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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

APR 12 1989

OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

MEMORANDUM

SUBJECT: Hazardous Waste Incinerator Inspection Manual

FROM: Jonathan Z. Cannon,
Acting Assistant Administrator

TO: Waste Management Division Directors
Environmental Services Division Directors
Regions I-X

Attached is the final Hazardous Waste Incinerator Inspection Manual. The manual was written to guide EPA and State RCRA inspectors in inspecting hazardous waste incinerators. This manual is also intended to be used as the training manual for a nationwide training course for inspectors to be held from May to August, 1989. Its use is exclusively for RCRA compliance personnel employed by or representing the U.S. Environmental Protection Agency or comparable state regulatory agencies. In addition, this document is not intended for public use and is withholdable under the Freedom of Information Act, 5 U.S.C. Section 552, Exemption (b)(7)(E).

The development of the Hazardous Waste Incinerator Inspection Manual was assisted by representatives from 12 States and 9 Regions, the Office of Enforcement and Compliance Monitoring, the Office of General Counsel, and the Office of Solid Waste. The HWI Inspection Manual will:

- provide inspectors with information on the current regulations and the latest regulatory developments;

- serve as a resource for general overview of different types of incinerators, their functions, designs, and operation problems;

- o guide inspectors, step-by-step, using checklists to prepare for upcoming inspections and actual on-site inspections, as well as provide information on post-inspection report preparations;

- o instruct inspectors on the proper ways to interpret monitoring equipment; to perform various calculations needed to determine compliance; and to identify potential violations.

If you have any questions on the <u>Hazardous Waste Incinerator Inspection Manual</u> or the upcoming training course, please call Emily Chow (FTS-475-9329) or Kate Anderson (FTS-475-9313), RCRA Enforcement Division.

Attachment

cc: Hazardous Waste Branch Chiefs, Regions I-X
RCRA Enforcement Section Chiefs, Regions I-X

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

APR 12 1989

OFFICE OF
SOLID WASTE AND EMERGENCY RESPONSE

MEMORANDUM

SUBJECT: Hazardous Waste Incinerator Inspection Manual Distribution

FROM: Scott Parrish, Chief
Guidance and Evaluation Branch
Office of Waste Programs Enforcement

TO: RCRA Branch Chiefs
Regions I-X

The purpose of this memo is to explain the rationale behind the number of copies and the distribution of the Hazardous Waste Incinerator Inspection (HWI) Manual that will be mailed to RCRA state and regional inspectors.

Unlike past guidance documents developed by this office, the HWI Manual concerns a technology currently concentrated in specific geographical areas. Some Regions have a large number of hazardous waste incinerators, while others have very few. Due to the Regional differences in the demand for this guidance, combined with cost-related printing limitations, EPA headquarters is distributing the HWI Manual in proportion to the number of incinerators found in each Region. To facilitate this distribution process, we have mailed the manuals to the first names that appear on our inspector mailing list, realizing that these inspectors are not necessarily the ones performing the incinerator inspections, nor the ones that will attend the training courses scheduled throughout the summer. Consequently, we are asking, via this memo, that the recipients of the manuals contact you to determine who will be attending the training course. There will be a limited number of manuals in reserve at Headquarters, available upon request.

We appreciate your cooperation in implementing the allocation of the manuals to the appropriate staff members in your offices. If you have any questions, please call Kate Anderson at FTS-475-9313 of my staff.

cc: State and Regional Hazardous Waste Inspectors

OSWER Directive No. 9938.6

HAZARDOUS WASTE INCINERATOR INSPECTION MANUAL

APRIL 1989
FINAL

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF WASTE PROGRAMS ENFORCEMENT
401 M STREET, SW
WASHINGTON, DC 20460

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The policy and procedures set forth herein, and internal inspection procedures adopted pursuant hereto, are intended solely for the guidance of RCRA compliance personnel employed by or representing the U.S. Environmental Protection Agency or comparable state regulatory agency. They are not intended to nor do they constitute rule-making by the Agency, and may not be relied upon to create a right or benefit, substantive or procedural, enforceable at law or in equity, by any person. The Agency may take any action at variance with the policies or procedures contained in this memorandum, or which are not in compliance with internal office procedures that may be adopted pursuant to these materials.

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ABBREVIATIONS

APC--Air Pollution Control.

AWFCO--Automatic Waste Feed Cutoff.

CEM--Continuous Emission Monitor.

DRE--Destruction and Removal Efficiency.

ESP--Electrostatic Precipitator.

FBI--Fluidized Bed Incinerator.

ID--Induced Draft.

IWS--Ionizing Wet Scrubber.

L/G--Liquid/Gas Ratio.

PCC--Primary Combustion Chamber.

PIC--Product of Incomplete Combustion.

POHC--Principal Organic Hazardous Constituents.

SCC--Secondary Combustion Chamber.

SDA--Spray Dryer Absorber.

WC--Water Column.

CHAPTER I

INTRODUCTION

This manual was developed as a guidance document and training tool for EPA, state, and local inspectors who conduct inspections of hazardous waste incinerators permitted under the Resource Conservation and Recovery Act (RCRA). A secondary audience is the incinerator permit writer, who may learn more about the contents of an enforceable permit by understanding the needs of inspectors. The manual provides:

- Background information on incinerators, air pollution control equipment, and incinerator regulations and permits (intended for individuals with limited experience in any of these areas).

- A descriptive approach for completing RCRA incinerator inspections.

- Objectives and priorities for inspections via a series of detailed checklists.

This manual serves as an incineration-specific supplement to The RCRA Inspection Manual (EPA 1988a), and is not intended to cover all of the general activities of a RCRA Compliance Evaluation Inspection. Although the scope is limited to "incineration," as defined by RCRA, much of the information and the approach presented in this manual could be useful in planning inspections of other thermal waste treatment facilities, such as hazardous waste boilers and industrial furnaces.

This manual reflects the current state-of-knowledge of the RCRA incineration program (as of January 1989). Regulations and guidance may change as new knowledge and experience are gained. With only a few years' experience in evaluating incinerators after they have been permitted, the

RCRA incineration program does not have extensive knowledge of "typical" or "predictable" long-term operational and maintenance problems associated with hazardous waste incinerators. As more experience is gained in this area, some changes in the approach to incinerator inspections may become appropriate.

The reverse is true for the traditional air pollution control devices. As a result of years of experience gained in the enforcement of air pollution control programs, EPA has accumulated an extensive base of knowledge of the long-term performance, maintenance, and reliability of devices such as wet scrubbers and fabric filters. Some of this experience is reflected in this manual. However, one objective of this manual is to provide a balanced approach to incinerator inspection that is in accordance with the technical priorities of current RCRA permitting guidance. Therefore, the inspection of air pollution control devices is treated only at moderate length in this manual, even though more specific information is available from EPA sources than for other incinerator compliance issues.

The inspection approach and activities developed in this manual rely heavily on a tailored checklist to identify the specific needs of an inspection for a particular site and to establish the inspector's time-use priorities. The contents of an inspection are based on limits and conditions established in a permit. However, a successful inspection also requires an inspector who can combine an inquisitive nature and a knowledge base to make the judgments needed in the field to provide clear, comprehensive documentation of the status of the incinerator's compliance with the interim status regulations or RCRA permit conditions.

Chapter II of this manual provides background information of potential use to inspectors concerning incinerators and air pollution control equipment. It reviews basic concepts and serves as a quick reference to assist the inspector in understanding the function and potential problems associated with key control and monitoring equipment.

Chapter III provides an overview of hazardous waste incinerator regulations and the permitting process. It also lists and describes the types of permit-limited conditions that an inspector will be evaluating during an inspection.

Chapters IV, V, and VI deal directly with conducting incinerator inspections. Chapter IV develops a step-by-step approach to planning and conducting an inspection. Chapter V discusses the documentation of potential violations, and Chapter VI addresses follow-up activities to the inspection and four special categories of incinerator inspections.

CHAPTER II

BACKGROUND TO INCINERATION

INDEX

CHAPTER II

BACKGROUND TO INCINERATION

LEARNING OBJECTIVES

- Introduce the basics of hazardous waste incineration including:
  - Fundamentals and operating principles
  - Major components
  - Types of incinerators
  - Types of wastes that can be incinerated
- Discuss the air pollution control devices used in hazardous waste incineration facilities including:
  - Types of devices
  - Basic principles
  - Potential problems
- Provide background on the process and emissions monitoring equipment used in hazardous waste incineration facilities.

A. INCINERATORS

A basic understanding of what incinerators are and how they work is a prerequisite to effective inspection of hazardous waste incinerators and enforcement of the RCRA regulations and permit requirements for those incinerators. Key elements are an understanding of the objectives of the incineration system and the key operating principles that allow those objectives to be met, a basic knowledge of the incineration system components and their function, and an understanding of indicators of poor performance that can result in failure to meet regulatory requirements.

These factors are discussed briefly in the four subsections below. The first subsection provides a survey of the fundamental properties of hazardous waste incineration. It outlines the objectives of the incineration system and defines the scientific/engineering principles that are keys to achieving these objectives. The second subsection addresses environmental releases and potential failures that lead to releases that are potential regulatory violations.

The third subsection provides an overview of the components of the combustion system and briefly describes the function of each component. The fourth subsection describes the four major classes of incinerators (or combustion units). For each class of incinerator, the basic design is described, the types of wastes compatible with that design are identified, and key operating parameters are defined.

References for additional information on incinerators are provided on page VII-3.

A-1. Fundamental Properties of Hazardous Waste Incineration

A hazardous waste incinerator is an enclosed, controlled flame combustion device system that is used to treat primarily organic and/or aqueous waste streams. The objectives of the incineration process are twofold. First, the high temperature environment in the flame zone and post-flame zone greatly reduces the hazardous characteristics of toxic, reactive, and ignitable wastes. In a properly designed and operated incinerator virtually all organic materials in the waste feed are decomposed into carbon dioxide and water. Second, the incineration process greatly reduces the mass and volume of waste material that must be disposed in land-based facilities.

While a properly designed and operated hazardous waste incinerator is an environmentally sound treatment technique, poorly designed, or more frequently, improperly operated incinerators can generate environmental releases that are potentially harmful to human health and to the environment. A key function of the inspector is to assure that the incinerator is operated in an environmentally acceptable manner. The paragraphs below describe the key operating factors that affect incinerator performance and identify points of environmental release from the process.

In principle, combustion of hazardous waste is a chemical process that is equivalent to combustion of fossil fuels to recover energy. It is a chemical reaction that involves rapid oxidation of the organic substances in the waste and auxiliary fuels. This violent reaction releases energy in the form of heat and light and converts the organic materials to an oxidized form.

Efficient combustion is achieved only when the proper amount of air is made available to the combustion chamber. Other factors influencing the completeness of combustion are temperature, time, and turbulence. These are sometimes referred to as the "three T's of combustion," and need to be given careful consideration when incineration systems are evaluated.

Each combustible substance has a characteristic minimum ignition temperature that must be attained or exceeded, in the presence of oxygen, for the oxidation reaction to proceed at a rate that would be characterized as combustion. Above the ignition temperature, heat is generated at a higher rate than it is lost to the surroundings, and the elevated temperatures necessary for sustained combustion are maintained.

Time is a fundamental factor in the performance of combustion equipment. The residence time of a constituent in the high-temperature region should exceed the time required for the combustion of that constituent to take place. Residence time requirements establish constraints on the size and shape of the furnace for a desired firing rate. Because the reaction rate increases with increasing temperature, a shorter residence time will be required for combustion at higher temperatures. Residence time can be calculated, but it is not measured directly; some indicatc of combustion gas flow rate is used as a surrogate.

Turbulence and the resultant mixing of organic materials and oxygen a also essential for efficient combustion. Inadequate mixing of combus- tible gases and air in the furnace can lead to emissions of incomplete combustion products, even from an otherwise properly sized unit with s ficient oxygen. Turbulence will speed up the evaporation of liquid ft for combustion in the vapor phase. In the case of solid fuels, turbu- lence will help to break up the boundary layer of combustion products formed around the burning particle. Under nonturbulent conditions, tl combustion rate is slowed by the decreased availability of oxygen to t surface reaction. Although turbulence is an important factor in good combustion, it cannot be monitored and an inspector generally will ha no way to assess turbulence. This issue is addressed within basic de: decisions.

A-2. Environmental Releases From Incinerators

The major concern of the inspector is to ensure that the incinerator operating within the conditions established in the facility's permit. The limiting conditions are selected to minimize environmental release

A simplified schematic of a hazardous waste incineration facility is shown in Figure II-1. This figure identifies key input streams to the incinerator and potential pathways of release. The waste stream generally is a complex mixture of organic and inorganic constituents.

As shown in the schematic, these constituents or their reaction produc can leave the incinerator via one of three pathways: (1) they can be emitted to the atmosphere either through the stack or as fugitive emis sions from the incinerator or from handling operations; (2) they can leave the facility as a solid residue in the form of bottom ash or as dry catch from the air pollution control equipment; and (3) they can b discharged as a liquid effluent from the air pollution control system.

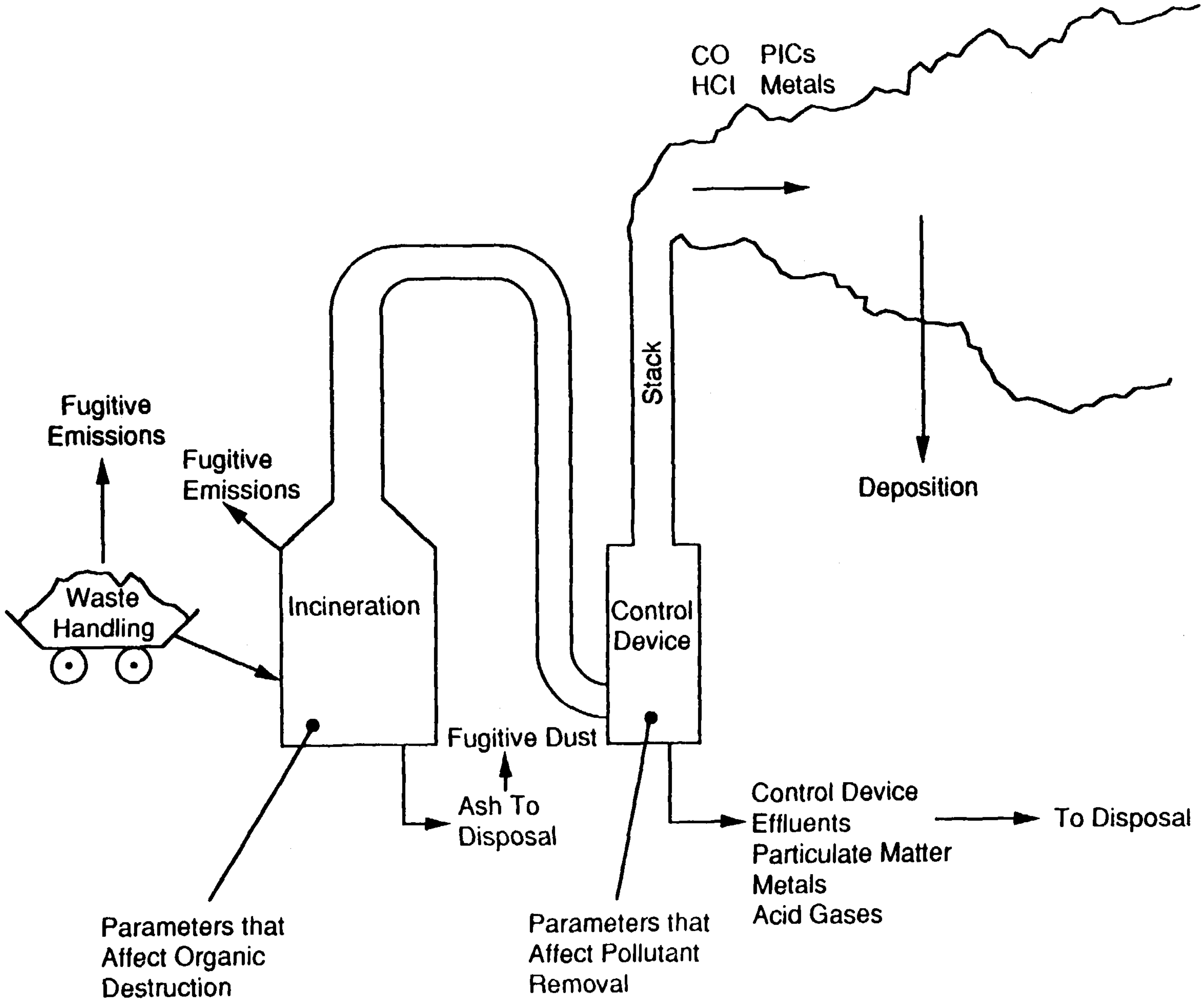


Figure II-1. Combustor environmental releases.

Four major groups of compounds are of environmental concern--hazardous organic constituents; hazardous metal constituents; acid gases generated from combustion of halides, sulfur, and phosphorus; and particulate matter. The potential pathways of each of these constituents through the incinerator are described in the following paragraphs.

Generally, waste streams are not fed directly to a combustor. They are stored, at least temporarily, in a drum or tank and frequently undergo one or more transfer operations before being fed to the combustor. If the storage and handling equipment is not sealed perfectly, volatile organic constituents in the waste can be emitted to the atmosphere as fugitive emissions. Spills also can occur during handling and transfer, and volatile organic constituents are emitted from this spilled material.

Wastes are fed from the storage source into the combustor. Under ideal conditions, all of the organic material in the waste would be converted to a completely oxidized form (CO_2, H_2O, and acid gases). However, since combustion is never 100% complete, organic constituents present in the waste or hazardous products of incomplete combustion (PICs) of those waste constituents are discharged from the combustion chamber via two pathways. The most likely pathway is with the stack gas, but organic constituents can be adsorbed on bottom ash. (The bottom ash is a hazardous waste if it is "derived from" a listed hazardous waste or if it exhibits any hazardous waste characteristics.) The materials that are contained in the bottom ash can be disposed in a land disposal unit or they can be emitted to the atmosphere during ash handling operations.

The materials that are exhausted from the combustion chamber with the combustion gases are transported to the air pollution control system. They can be collected by the control system and disposed with the residue from the system, or they can penetrate the control systems and be discharged to the atmosphere. Available information suggests that very few air pollution control systems achieve significant removal of volatile organics. Consequently, most organic constituents that are not destroyed in the combustor are emitted to the atmosphere from the stack. However, significant control of some semivolatile PICs (i.e., dioxins and furans) has been demonstrated with dry scrubbers and wet scrubbers. Wet scrubbers have demonstrated significant control of low molecular weight organic acids, aldehydes, and ketones.

Unlike organic constituents, metal constituents are not likely to be emitted as fugitives during waste storage and handling, and they are not "destroyed" during the combustion process. Rather they are partitioned among the incinerator effluent streams. As with the "noncombusted" organic constituents, metal constituents can leave the combustion chamber as bottom ash or in the combustion gas. The relative distribution of the metals between these streams is based on such factors as the chemical form of the metals charged to the combustor, the localized reaction atmosphere in the combustion chamber, localized chamber temperatures, and localized chamber airflows.

Metals that leave the chamber as bottom ash ultimately can reach a land disposal site or can be lost to the atmosphere as fugitive emissions. Metals can leave the combustion chamber in the gas stream either as entrained particulate or as a metal vapor. Again, the material can be captured by the control system or can penetrate the control system and be discharged to the atmosphere. The removal efficiency of the control system depends on whether the metal is emitted as a particle or a gas.

Generally, air pollution control systems are ineffective in controlling gas phase metals constituents. Dry scrubbers operating at sufficiently low temperatures do collect significant amounts of volatile metals from flue gases (e.g., 80% to 90% removal of mercury has been demonstrated). If the gas stream is presaturated and cooled upstream of a venturi, then a wet venturi will be able to collect the volatile metals constituents that are condensible. The removal of metal constituents that enter the control system as particulates depends on the particle size distribution for each constituent as described in Section II-B. Any by-product of the air pollution control system (i.e., catch from a control device, scrubber effluent) is handled as hazardous waste if "derived from" a listed hazardous waste or if it exhibits any hazardous waste characteristics.

Elements such as chlorine, sulfur, and phosphorus, if present in the waste, can react to form "acid gases" (acidic combustion gases). Since many of the toxic organic compounds found in hazardous waste contain chlorine, the formation and removal of hydrogen chloride gas from burning chlorinated wastes is an important issue for hazardous waste incinerators.

A-3. Hazardous Waste Incinerator Components

Each incineration facility contains the same basic types of equipment, but no two facilities are exactly alike. At the heart of each facility is at least one combustion chamber (i.e., combustor). Additional equipment is necessary to bring the waste into the combustion chamber and to deal with combustion products, as illustrated in Figure II-2.

The common elements of each incineration facility are:

- Waste storage and handling system
- Air/gas handling system
- Combustion chamber(s)
- Auxiliary fuel feed
- Air pollution control system
- Residuals handling system
- Process instrumentation

Equipment used for waste storage and handling varies according to the characteristics of the waste and the degree of flexibility required by the incineration facility. Tanks are used to store liquid waste. An on-site industrial facility may use flow-through tanks which serve primarily to equalize waste production rates and waste destruction rates. Commercial incineration facilities may use an integrated "farm" of tanks, with some tanks used for storing each batch of waste received and some used for blending similar types of waste together. Some facilities may also use temporary storage tanks, such as railroad tank cars or tanker trucks.

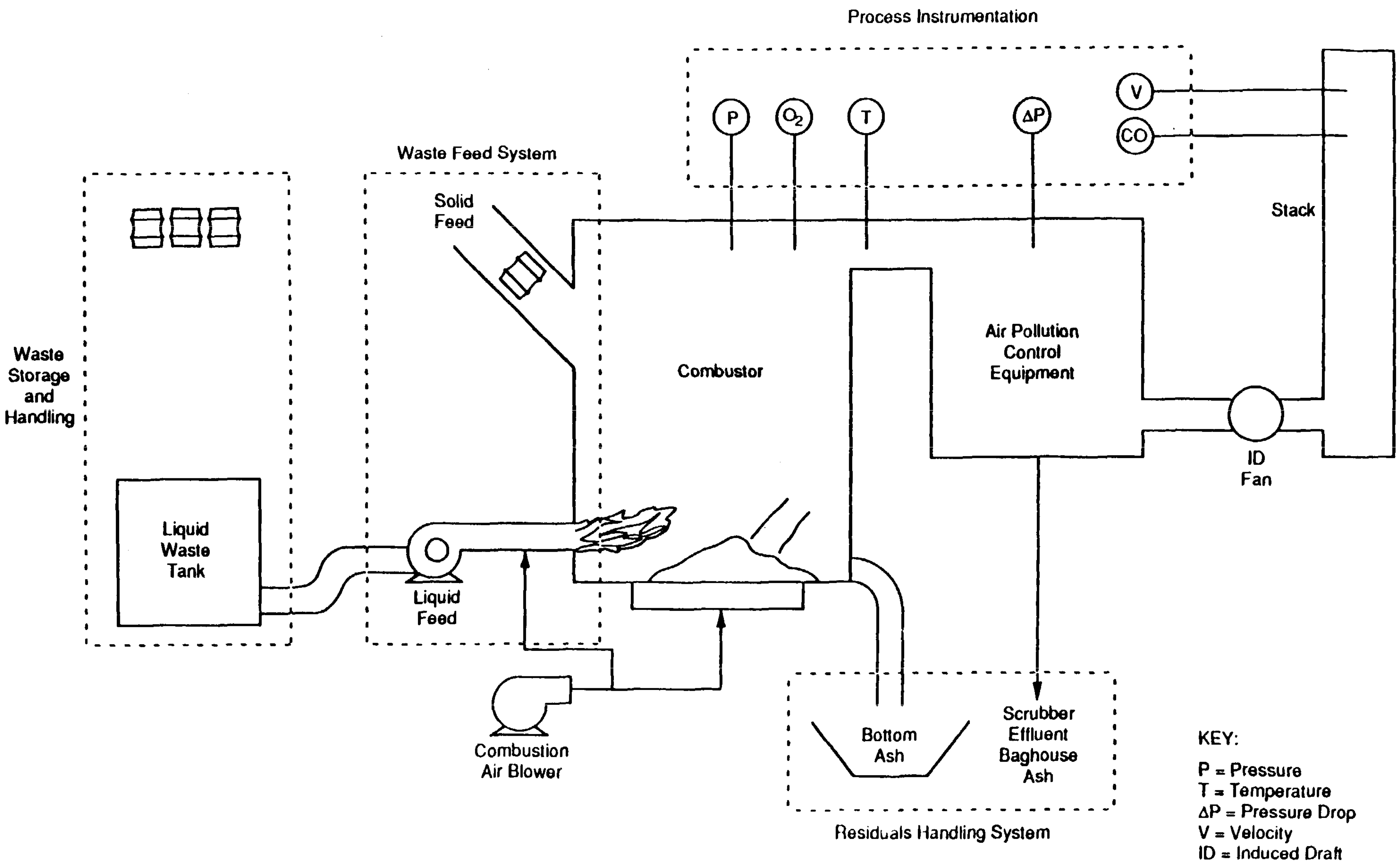


Figure II-2. Components of a hazardous waste incinerator.

A key feature of a feed tank is its ability to mix the contents to avoid layering either by stirring or by recirculating the contents. In some cases the tanks are heated to keep the contents less viscous and to avoid precipitating out less soluble constituents.

Many facilities handle solid waste via containers such as 55-gal steel drums, combustible drums made of plastic or heavy cardboard fiber, or cardboard boxes. A drum storage shed is an example of a storage facility for containerized solid waste; handling facilities may include scales, conveyor belts, or drum shredders. Bulk solids may be stored in a silo or on a tipping floor.

The role of the waste feed system is to introduce waste to the incinerator. The feed system will vary according to the physical state of the waste. For example, it may include piping, pumps, and burner systems with atomizing nozzles for liquids or conveyor belts and charging hoppers for solids. This equipment will be described in more detail later in this section.

The air or gas-handling system includes the fans or blowers that move the intake air and the combustion gases, and the motors that drive the fans. Generally, one or more blowers are used to supply combustion air to the incinerator at one or more points:

- Induced draft (ID) fans use negative pressure (e.g., a vacuum) to pull gases through the incinerator.

- Forced draft fans provide positive pressure, pushing gases in.

The combustion chamber provides a high-temperature environment for the desired gas retention time, typically in the range of several tenths of a second to several seconds. The nominal gas temperature within the combustion chamber may be set anywhere from roughly 1100° to 2400°F, depending upon the design and application of the incinerator. Key design factors include:

- Time (gas-phase retention time; also solids retention time for some units).

- Temperature.

- Turbulence (how well-mixed the air, waste vapors or solids, and the combustion gases are).

- Oxygen level (e.g., excess oxygen systems or low-oxygen pyrolysis systems).

Most combustion chambers consist of a steel outer shell, lined on the inside with refractory such as fire brick. Refractory material assists in maintaining a stable temperature within the combustor with minimum energy loss and withstanding the stresses of heating up and cooling down. The combustion chamber may be in the shape of a cylinder, or less commonly, a rectangular box. Its orientation may be either horizontal or vertical.

Many incinerators use two combustion chambers in series. The first chamber is where most of the hazardous waste is fired, and is known as the primary combustion chamber (PCC). The next chamber, positioned directly downstream, is known as the afterburner or the secondary combustion chamber (SCC); it typically fires fuel and/or high energy liquid waste. The major purpose of a PCC is to partially combust organic material and to heat up and convert any remaining organic solids/liquids into a vapor form. The major purpose of a SCC is to subject vaporized waste to a high enough temperature for a long enough time to ensure near-complete destruction.

Incinerators require auxiliary fuel, such as fuel oil, natural gas, or high-energy nonhazardous wastes, to bring each combustion chamber up to the minimum combustion temperature required in the permit prior to accepting hazardous wastes. In addition, a flow of auxiliary fuel may be maintained to one or more combustion chamber during the combustion of those hazardous waste streams that do not provide adequate heat input to maintain the minimum combustion temperatures. Although some organic waste streams may have high heating values and serve as fuel to the incinerator, some wastes, such as those with high water content or high inorganic content, may require supplemental fuel for adequate incineration.

The air pollution control system is designed to remove solid particulate matter and acid gases from the gases leaving the combustion chamber(s). It will be discussed at length in the next section, and will only be described as a general system in this section. Sometimes the stack is considered to be part of the air pollution control system. Its main function is to carry the combustion gases and any remaining pollutants high enough into the atmosphere that dilution will generally reduce any hazard before the gases may reach ground level again.

The residuals handling system handles the solid and liquid by-product of the incineration facility. Solids handling systems are used to remove heavier, larger particles of bottom ash from the combustor or lighter, smaller particles of fly ash that carry part way through the air pollution control devices. Some residual materials are removed in an aqueous (water) stream by air pollution control scrubbers. The wastewater is treated prior to discharge.

All of the important process functions of the incinerator, including the waste feed system, the combustion system, the air pollution control system, and the residuals handling system, need to be monitored using appropriate instruments. The instrument sensors are usually located on or within the incineration system itself, while the readout devices (gauges, strip-chart recorders, etc.) are usually located in a central control room. Instrumentation used for monitoring the process and specific gases are described in the last section of this chapter.

A-4. Major Classes of Incinerators

Generally no two incinerators look alike, but only four basic design types are actually in use for most hazardous waste incineration applications. Each of these types will be discussed in the following paragraphs. As of November 1988 there were 205 hazardous waste incinerators on a permit track in the records of EPA's Office of Solid Waste. Most are liquid injection incinerators or rotary kiln incinerators.

Many incinerators operate on a 24-hr/day, 7-day/week basis except for periodic scheduled maintenance (e.g., annual or every 6 months) and unscheduled repairs. This is particularly the case for commercial incinerators, industrial incinerators receiving continuous waste feeds associated with a continuous manufacturing process, and industrial incinerators receiving large-volume waste streams from multiple operations. However, many smaller on-site industrial incinerators and government facility incinerators may operate on a shift basis or on an irregular basis, depending on the amount of waste feed available.

The subsections below describe four most common types of hazardous waste incinerators. Each subsection identifies the type of wastes that are compatible with the combustor, describes the system, and identifies key operating parameters.

A-4-a. Liquid Injection Incinerators

The simplest type of hazardous waste incinerator is the liquid injection incinerator, also known as the liquid-fired incinerator. These units can handle only a limited range of waste feed types, including:

- Liquids
- Pumpable slurries
- Gases

Liquids can include organic wastes, which contribute some fuel value, or aqueous wastes, which provide minimal fuel value and may tend to quench (cool) the hot combustion gases. Slurries are liquids with a high suspended solids content. If a slurry can be transported with a pump, it can generally be fed to the combustor using conventional types of liquid waste firing equipment. Gases are sometimes fed to a liquid incinerator, but usually only to on-site industrial incineration facilities that may continuously ventilate a vessel in a chemical process and pipe the ventilation gases directly into the incinerator. (It should be noted that uncontained gases are not solid wastes as defined in Section 1004 of RCRA, as amended.)

A liquid injection incinerator usually has only a single combustion chamber, operated at high temperature (generally 1600° to 2000°F). The combustion chamber may be oriented horizontally or vertically. Vertical combustion chambers may have the waste introduced with an upward flame (up-fired) or with a downward flame (down-fired). Because liquid incinerators do not handle solids, they usually process wastes of lower ash (inerts) content, and do not require as sophisticated an air pollution control equipment as other incinerator types. Some have only a stack following the combustion chamber. An example of an up-fired, forced draft system with no air pollution control devices is shown in Figure II-3.

Key performance parameters for a liquid injection incinerator are temperature, residence time, combustion air, and atomization of the waste feed. Atomization involves breaking the liquid into tiny droplets that have a high ratio of surface area to volume. The liquid then can be vaporized quickly, and the turbulent action provides maximum exposure to combustion air, thus allowing an active, high-temperature flame. The effective atomization of wastes allows a liquid injection incinerator to destroy wastes with typically only a single combustion chamber.

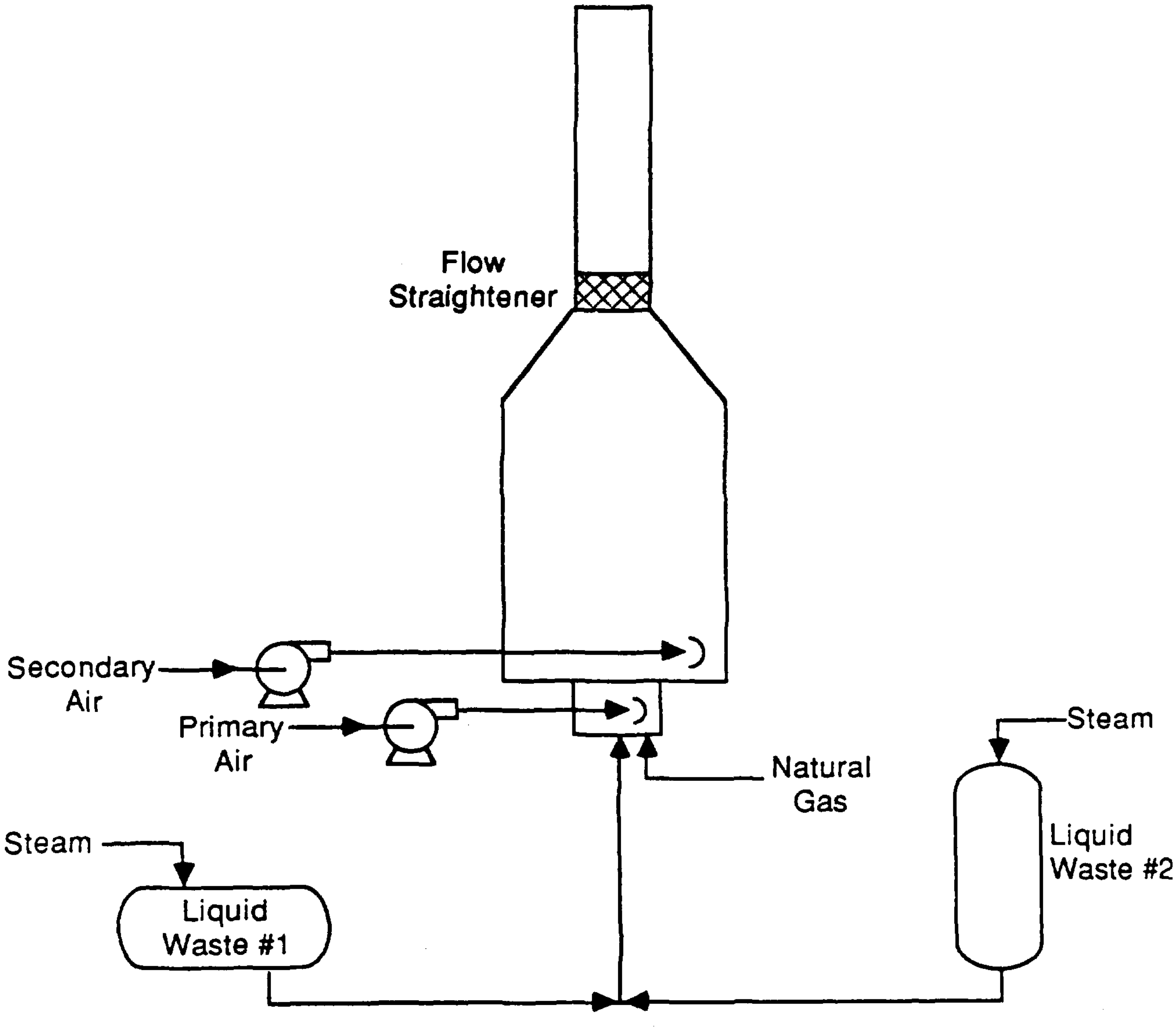


Figure II-3. Schematic of a liquid injection incinerator.

A-4-b. Rotary Kiln Incinerators

The rotary kiln incinerator is the most versatile type of incinerator, and is used accordingly for many commercial applications. Its most significant feature is that it can handle solids in addition to liquid waste feeds. The rotary kiln incinerator usually employs two combustion chambers. The primary combustion chamber is the kiln, which is a refractory-lined cylinder that slowly revolves. Often solids are fed into the upstream end of the kiln. The solids slowly migrate downstream (i.e., in the same direction as the gas flow); this migration is facilitated by the kiln's rotation and its slight inclination. The solids are broken up mechanically and decomposed, with much of the organic material volatilizing. Residual matter, in the form of ash, drops out at the downstream end of the kiln. An example of a kiln is shown in Figure II-4.

The kiln normally fires liquid waste, in addition to solids, and may also fire auxiliary fuel. Kilns typically operate in an excess air mode to provide as much burnout of the solids as possible. Temperature is maintained sufficiently high to volatilize any noncombusted organic material, so that organic gases pass into a secondary chamber where more complete oxidation and destruction occurs. Some systems have a transition/expansion chamber intermediate between the kiln and the SCC.

Kilns may receive bulk solids (contaminated soil and ash, solid by-products, off-spec products, etc.), sludges (wastewater sludge, production sludges, etc), and liquids (organic liquids, contaminated waters, etc.). Facilities may receive a combination of hazardous and nonhazardous wastes.

Containers that may be used for feeding liquids, sludges, or solids include drums, cans, boxes, and bottles. Sludges, if pumpable, may be fired continuously via an injector known as a lance. The afterburner or SCC normally receives only waste or fuel with high energy value.

Key performance parameters for the kiln are temperature, solids residence time, containerized volatile feed rate, and pressure.

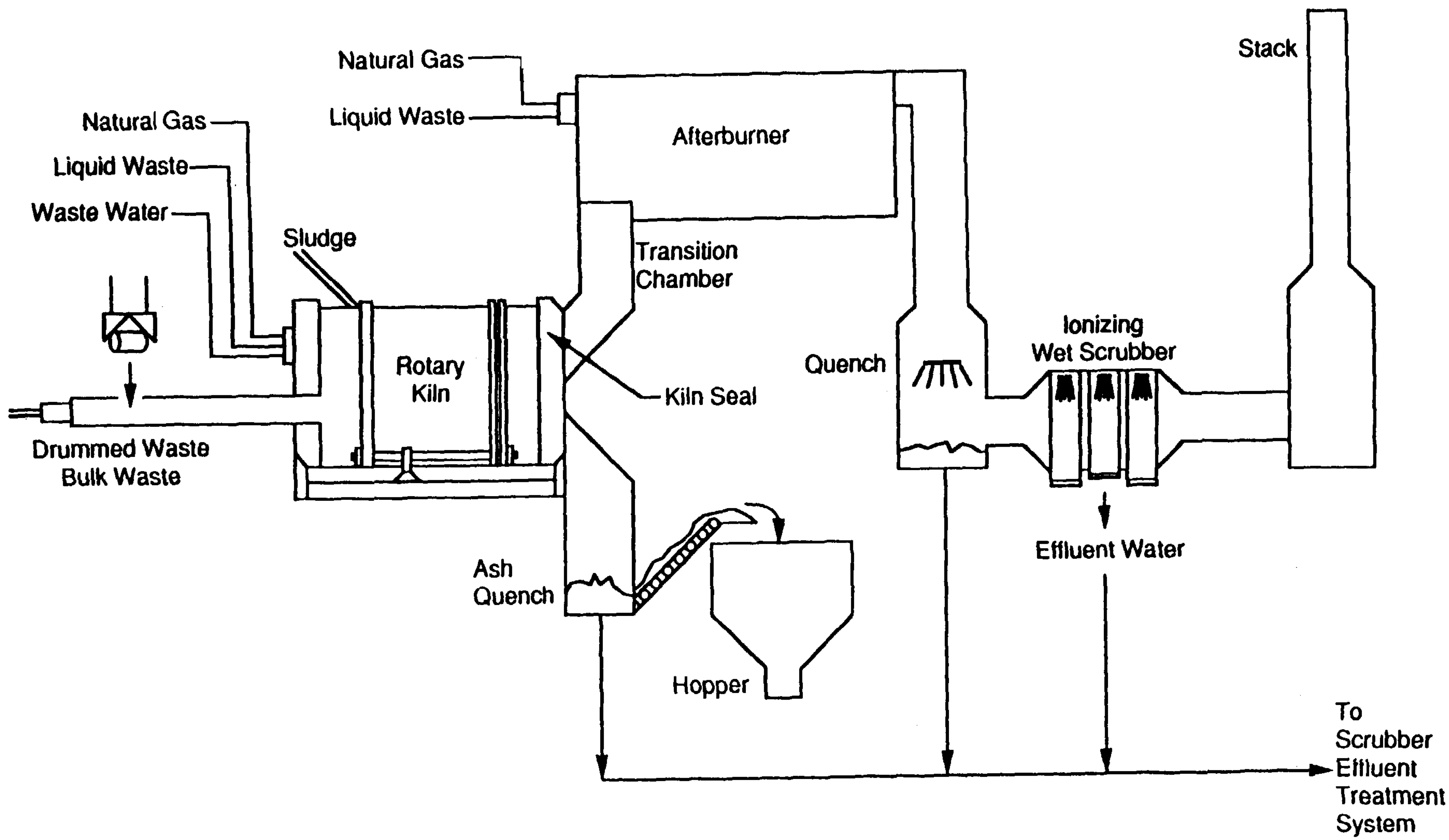


Figure II-4. Example rotary kiln incinerator system.

The rotary kiln normally operates under negative pressure (draft), as there is not a complete seal between the moving kiln and the stationary SCC or other transition chamber. These seals may leak, but as long as the kiln is operated under negative draft, only in-leakage occurs and fugitive emissions are prevented. However, if excess quantities of containerized volatiles are fed to the kiln, the kiln can experience intermittent episodes of positive pressure as these materials evaporate rapidly. If the pressure becomes positive, fugitive "puff" emissions can be generated at the seals. It is also important that the kiln seals be maintained properly to prevent fugitive emissions.

A-4-c. Fixed Hearth

The fixed hearth incinerator, like the rotary kiln, can accommodate solid wastes. However, it is somewhat less versatile, as it cannot easily fire bulk solids on a continuous basis. The types of waste feeds suitable for the fixed hearth include liquids or slurries, sludges, and solids.

The fixed hearth is so named because the bed on which the solids are fired is immobile; in fact, the complete PCC is fixed. The primary chamber is normally followed by a SCC or afterburner. Solids are introduced in one end of the hearth, and noncombusted material (ash) is moved along the floor of the chamber by a mechanical ram or manually. An example of a fixed hearth design is shown in Figure II-5.

Many smaller capacity incinerators that handle solids are of the fixed hearth design. There are fewer moving parts than for a kiln, which makes up-keep simpler. Key performance parameters for a fixed hearth include temperature and solids residence time.

A-4-d. Fluidized Bed Incinerators

The fluidized bed incinerator (FBI) uses a moving bed of inert particles in the bottom section of the combustor to improve the transfer of heat to

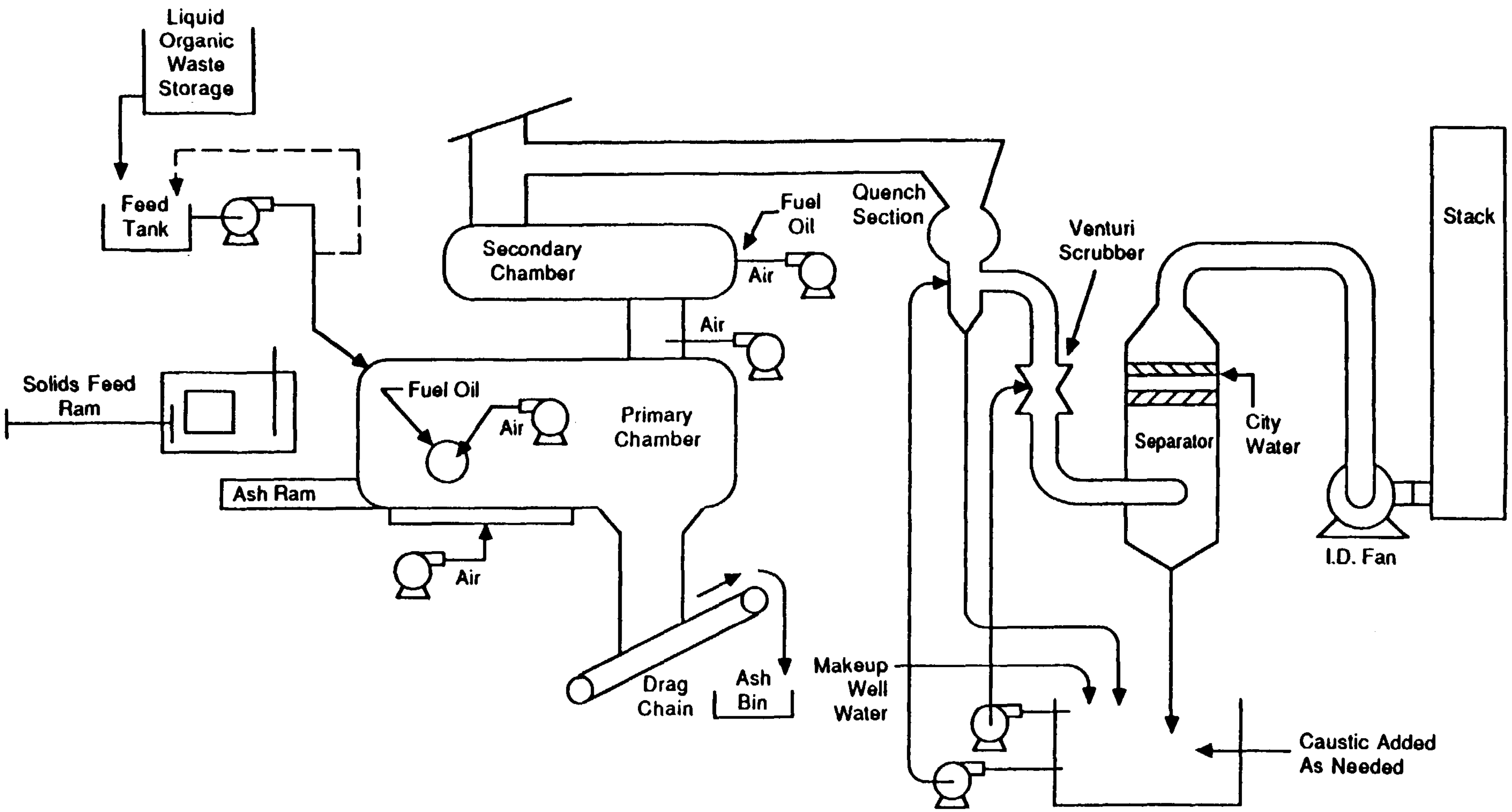


Figure II-5. Schematic of a fixed hearth incinerator.

the waste streams to be incinerated. FBIs are less versatile than rotary kiln incinerators or fixed hearth units, in that they cannot handle containerized waste directly. However, they are often operated at lower temperatures than other types and are more energy efficient in that regard.

The types of wastes handled by FBIs include:

- Gases
- Liquids
- Sludges
- Granulated solids

An illustration of a FBI is shown in Figure II-6. The <u>bed particles</u> (sand or other inert particles) are lifted up and kept in motion by a stream of <u>air</u>. The velocity of the air is critical to the successful fluidization of the bed; with too low of a velocity, the particles are not lifted off the bottom of the combustor, but with too high of a velocity, the particles are carried out of the chamber.

Some units operate with an intentionally high degree of carryover of bed material out of the combustor, and most of the particles are caught in a cyclone and circulated back into the combustor to make up the bed as needed. This type of unit is known as a <u>circulating bed combustor</u>.

FBIs operate as forced draft systems; usually only one blower is used for both <u>fluidizing</u> the bed and providing a source of <u>combustion air</u>. The operating temperature for the bed is typically 1400° to 1600°F. However, the freeboard temperature ("freeboard" is the volume within the combustor above the bed) can be lower than the bed temperature because of heat loss or higher than the bed temperature because of combustion within the freeboard. Usually there is only one combustor, but some systems use a higher temperature afterburner. The combustion gases can have high particulate loading as ash and sand particles become airborne.

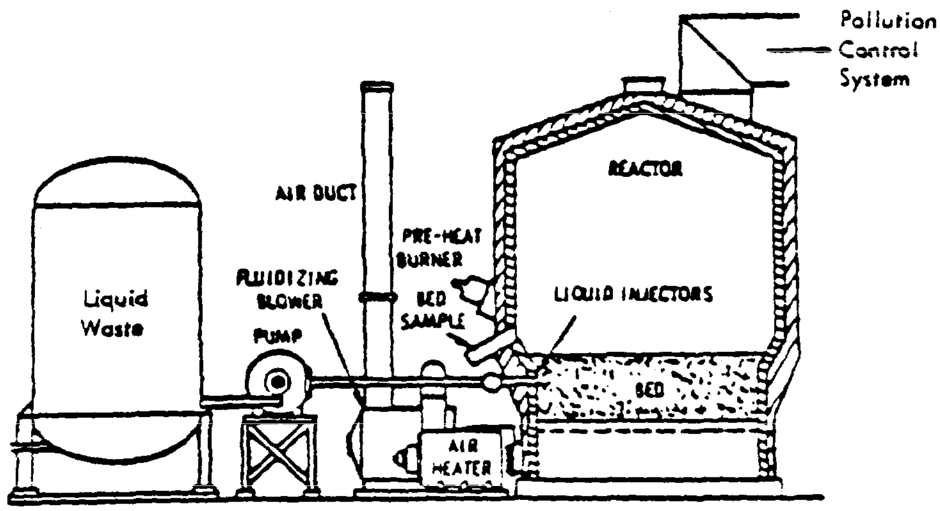


Figure II-6. Schematic of a fluidized bed.

Key operating parameters include:

- Airflow rate/distribution
- Bed temperature
- Bed condition

The bed condition is critical to the incinerator's operation. The quantity and type of ash present in the waste is important in maintaining the bed properties. If the bed accumulates ash more rapidly than it is lost, excess material must be removed through a tap valve. Other systems may need additional sand or other material as loss occurs.

The bed condition is normally monitored by a series of thermocouples placed around the periphery of the bed. The temperature is normally uniform. A divergence in indicated temperature by one thermocouple is an indication of poor fluidization or buildups in that region.

The FBI provides good contact between waste and combustion air. As the result of lower operating temperatures and lower excess air levels, however, there are sometimes higher emissions of carbon monoxide (CO) and hydrocarbon than with other incinerators. As needed, an afterburner can be used to reduce levels of these by-products in the stack gases.

B. WASTE FEED SYSTEMS

B-1. Liquid Waste Feed Systems

Liquid waste feed systems act to transport, mix, and atomize the waste. Liquid wastes are normally fed to an incinerator using an atomizing nozzle, which also may be called a waste feed gun. One or more nozzles may be incorporated into a burner assembly that may also contain ports for injecting combustion air, and baffles for developing turbulence.

Liquids may be atomized in either of two ways, mechanically or by an atomizing fluid. Mechanical atomizers involve some type of mixing motion to break up the liquid waste or fuel into tiny droplets. Ultrasonic systems may also be used for mechanical atomization.

Fluid atomized nozzles are more commonly used for incinerators than are mechanical ones. The atomizing fluid (steam or air, or sometimes nitrogen) provides the energy to break up the liquid into small droplets.

The key operating parameters for atomizing systems include:

- Waste feed viscosity
- Waste feed flow rate (turndown)
- Atomizing fluid pressures
- Solids concentration and size

All of these variables affect atomization. The turndown is a calculated ratio of the nominal or maximum design flow rate to the actual monitored flow rate for a particular nozzle.

In some cases liquids may be introduced via injection nozzles that are not atomized, but such nozzles would normally be used in the primary chamber of a two-combustor incinerator. Similarly, semisolid or sludge wastes may be fed by screw augers or lances into a primary chamber.

B-2. Solid Waste Feed Systems

Solids may be fed to incinerators in batches, such as in drums. The containers are transported by conveyor systems or manually, and are introduced to a charging system that consists of a steel box with at least two doors. To feed a container to the combustor, the outer door is closed and the inner door is opened, and the charge is forced into the combustor by either a mechanical ram or conveyor, or by gravity, in the case of charging systems on the top of the combustor. This multiple door system prevents gases from escaping the incinerator or unwanted air from entering, and allows for more stable operation in the batch firing mode. Side-charging systems or top-charging systems can be used. Examples of both systems are shown in Figure II-7.

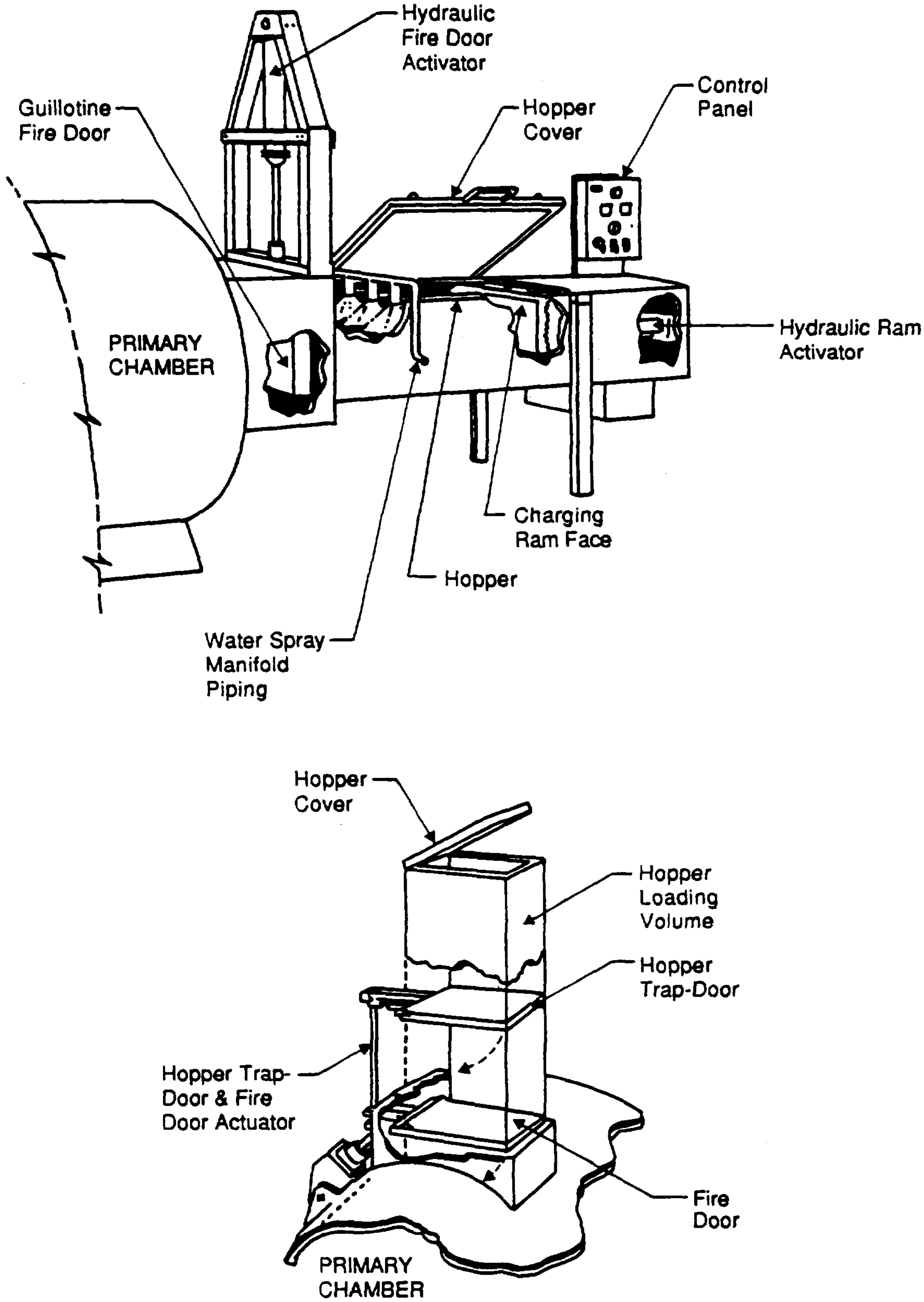


Figure II-7. Side-charging and top-charging solid waste feed system.

Some potential problems for solids-handling systems for inspectors to note include uncertainty in the feed rate measurement, plugging of the charging doors, and fugitive leaks.

C. AIR POLLUTION CONTROL DEVICES

C-1. Introduction

The purpose of this section is to supply the reader with the specialized information needed for inspecting/evaluating air pollution control (APC) devices on hazardous waste incinerators. This section provides RCRA inspectors with a concise body of pertinent information, and includes references for more detailed information on control technologies and inspections.

The six most common types of APC technologies installed on HWIs will be identified and discussed. Descriptions of their purpose, principle of operation, and performance parameters are provided along with brief discussions of the use of instrumentation to assess/diagnose common performance problems. The types of APC technologies described in the manual include three wet scrubber designs (venturi, packed bed, and ionizing wet scrubber); two dry scrubber designs (rotary atomization, and dual-fluid nozzle atomization); and one fabric filter design (pulse cleaning). (Another traditional APC technology, the electrostatic precipitator, typically has not been applied to hazardous waste incinerators and is not discussed in this manual.)

The six APC technologies discussed represent most of the conventional and emerging technologies installed on incinerators requiring control of particulate and/or HCl emissions. Most conventional APC technologies are designed for and designated as either particulate control or gaseous control. Some emerging technologies (e.g., ionizing wet scrubbers and dry scrubbers) are designed to be effective for both particulate and gaseous control by using components that are principally responsible for particulate or gaseous control.

Either a quench chamber or waste heat boiler is needed to cool ("quench") and control the incinerator gas stream from about 2000°F to about 450°F for protection of the APC equipment. Many incinerators use a quench chamber with water sprays to cool and humidify the incinerator gas stream. A quench chamber is popular because the humidification process pretreats the gas stream for enhanced performance of the APC equipment. A waste heat boiler or heat exchanger is sometimes installed to reduce and control the temperature of the incinerator gas stream. The heat recovered from a boiler can be used for space or process heating.

The information on APC technologies is intended to help prepare regulatory agency personnel to conduct an inspection on the types of APC equipment commonly found on RCRA incinerators. Permit conditions generally are specified for the important parameters that affect air pollution control equipment. The permit requires that the air pollution control system be consistent with the limits on these parameters when hazardous wastes are fed to the incinerator. Some permits require actuation of the automatic waste feed cutoff when the APC operating conditions move outside specified ranges for the performance parameters. Specific problems associated with APC equipment on hazardous waste incinerators may stem from variation with waste feed characteristics, combustion conditions, particle size distribution and particulate concentration, and acid gas concentrations. Regulatory agency inspection personnel need specialized information on APC technologies (a) to determine that the APC performance parameters are maintained on a continuous basis, and (b) to certify that emission limits are not being exceeded.

C-2. Wet Scrubbers

Wet scrubbing involves (in many cases) a quench for cooling and saturating the flue gas with water, followed by an inertial scrubber for particulate removal and a packed bed scrubber for acid gas removal. Venturi, packed bed, and ionizing wet scrubbers (IWS) are the common types of wet scrubber systems used on hazardous waste incinerators. These three types of wet scrubbers are addressed in this section.

Many of the wet scrubber systems installed on incinerators consist of a variable throat venturi followed by a packed bed tower and mist eliminator. These systems are designed to operate at a pressure drop in the range of 20 to 60 inches water column (in w.c.), depending on performance or permit condition requirements. The variable throat venturi design accommodates varying gas flow rates while maintaining a constant pressure drop by changing the venturi throat area. A pH controller system, including a pH electrode and transmitter, can be used to adjust the flow of a caustic solution (e.g., sodium hydroxide, sodium carbonate) to the scrubber system to respond to varying acid gas concentrations.

Several ionizing wet scrubber (IWS) systems are installed on RCRA incinerators. These systems consist of one or more modules that comprise an ionizing section followed by a packed bed tower and mist eliminator section. In IWS systems, the ionizing section(s) is responsible for charging the particles and the packed bed section(s) is responsible for removing the charged particles and acid gases from the exhaust gases. A pH controller system, including a pH electrode and transmitter, can be used to adjust the flow of a caustic solution to the scrubber in response to varying acid gas concentrations.

Typical operation and maintenance problems for wet scrubbers include fan imbalance, nozzle wear or plugging, pump seal leaks, pH controller drifts, pH electrode fouling, and wet-dry interface buildup.

Any effluent from a scrubber system must be handled as a hazardous waste if it is "derived from" a listed hazardous waste or if it exhibits any hazardous waste characteristics. If the effluent is not a hazardous waste, frequently the effluent can be treated by an industrial wastewater treatment facility or a public treatment plant.

The following material provides a general background on the types of wet scrubbers that an inspector may expect to see installed at incineration facilities. Each subsection briefly describes the operating principles of the scrubbing system and identifies important operating parameters that inspectors generally will see addressed in permits. Typical operation and maintenance problems that an inspector might observe during an inspection also are described.

Inspectors should refer to other EPA references (see reference list) for types of scrubbers not specifically discussed in this report.

C-2-a. Venturi Scrubbers

(1) Operating Principles for Venturi Scrubbers

(Note: Materials from EPA 1984, EPA 1982, Calvert, and Andersen 2000, Inc. were used in the following discussion.)

A typical venturi scrubber is illustrated in Figure II-8. The gas stream enters the converging section and is accelerated approximately by a factor of 10. The liquor is injected just above the throat, and fine droplets are formed from the shearing action of the high gas velocities. Impaction of particles occurs on the droplets which are moving slower than the gas stream. The gas stream is decelerated in the diverging section. After the venturi section, the gas stream passes into a mist eliminator or into a packed bed tower followed by a mist eliminator. The function of the venturi is only to effect collision between the droplets and the particles; and the removal of the particle laden droplets from the gas stream only occurs in the mist eliminator.

There are a large number of variations to the standard venturi configuration. Figure II-9 illustrates a rectangular throat design.

A popular variable venturi throat design is included in Figure II-10 illustrating an adjustable cone-shaped baffle in the throat to increase or decrease throat cross section without affecting scrubber geometry. The conical baffle is actuated by manual, hydraulic, or electrically driven mechanical linkages. The adjustable actuator is mounted externally to the gas stream to allow maintenance without shutdown. The variable venturi throat design allows a constant venturi throat gas velocity and constant pressure drop to be maintained under highly variable gas flow conditions, thereby maintaining constant particle collection efficiency.

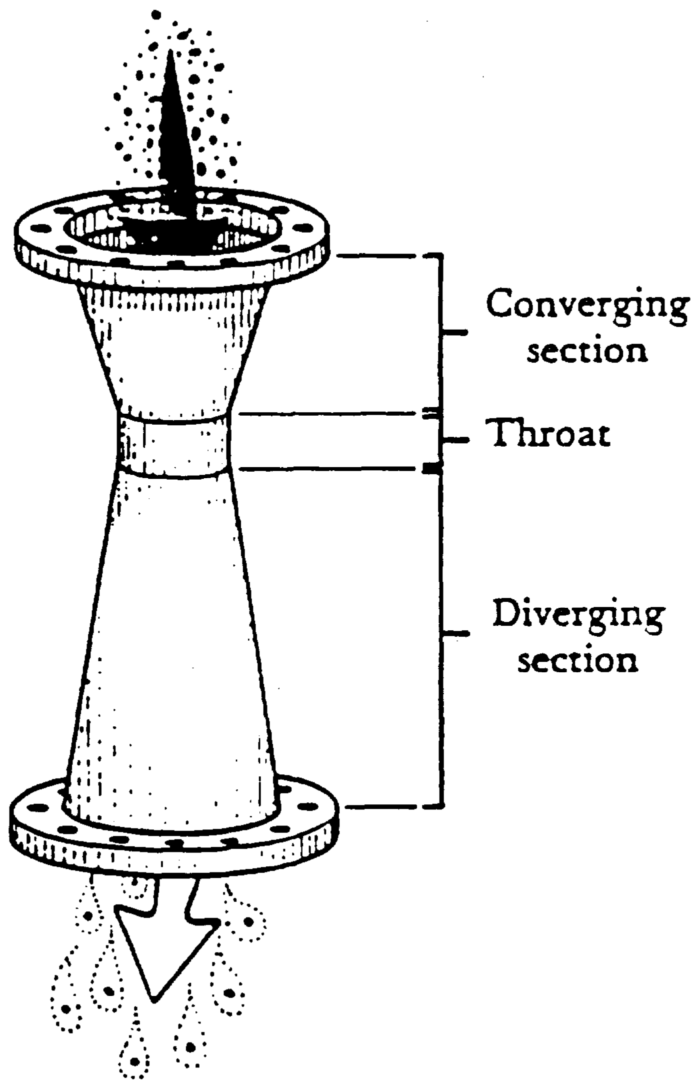


Figure II-8. Venturi configuration.

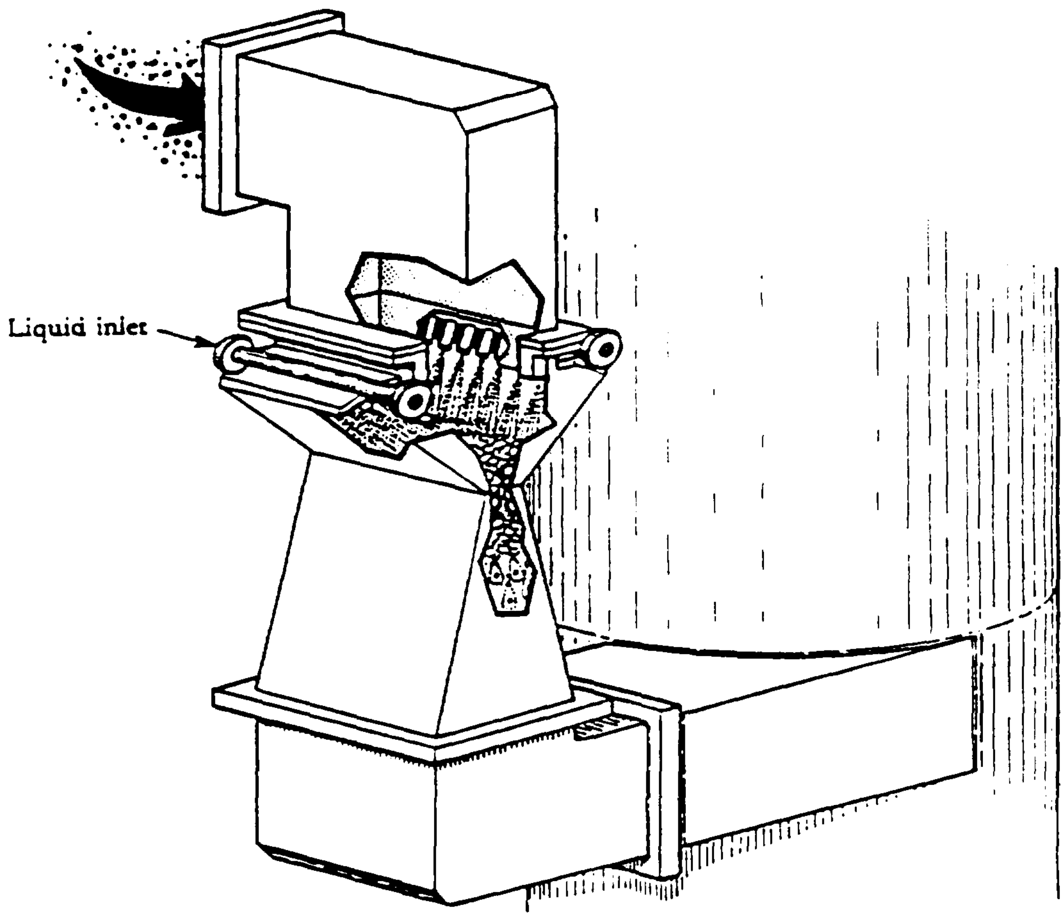


Figure II-9. Spray venturi with rectangular throat.

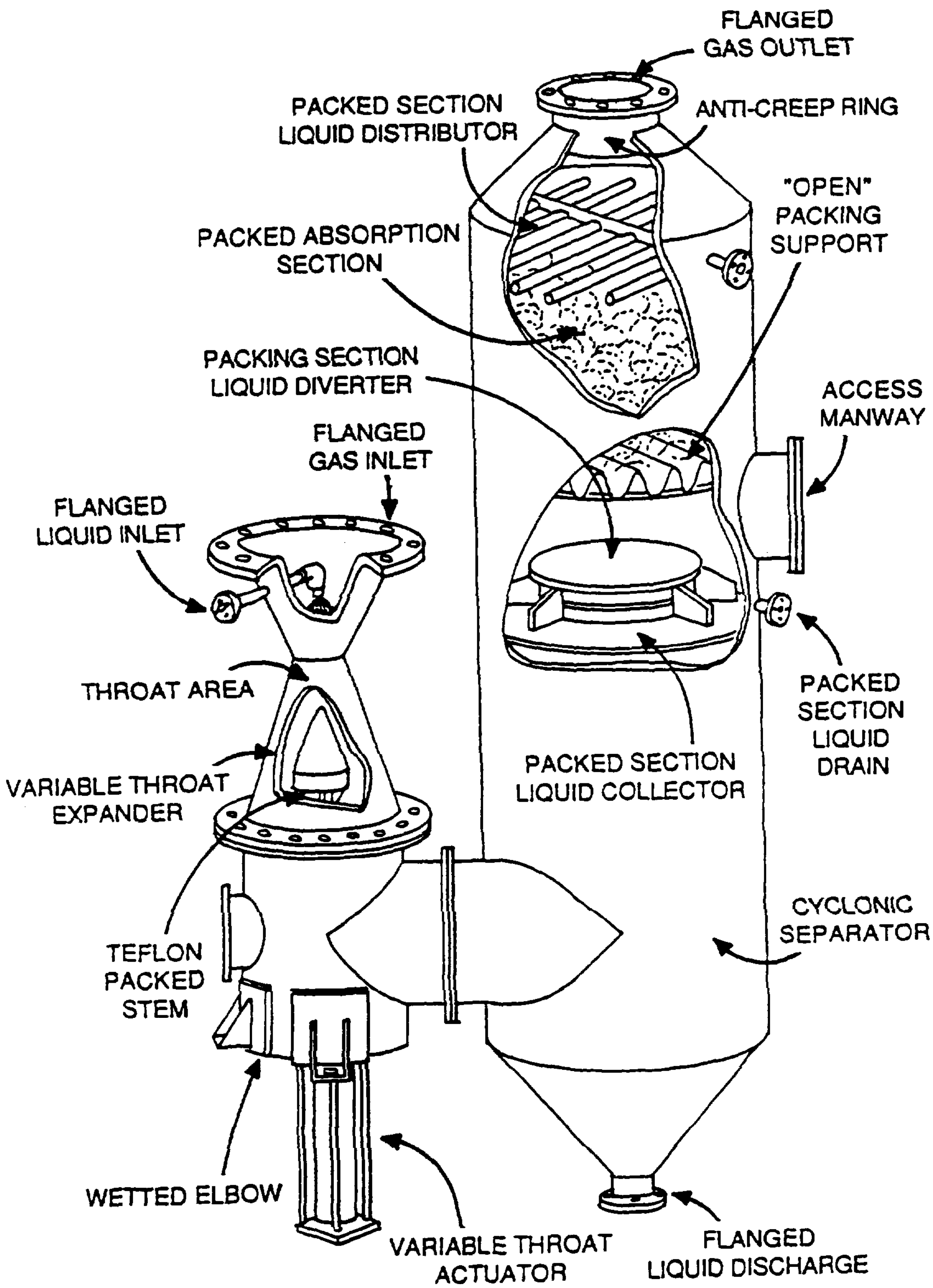


Figure II-10. Variable throat venturi with packed bed.

Some venturi designs include provisions to reduce wear due to erosion and abrasion of the section immediately downstream of the venturi. The momentum and abrasive nature of the particle-laden droplets produced in the high velocity venturi section can erode the material downstream of the venturi. The wetted elbow shown in Figure II-10 allows the small pool of water to absorb this abrasion, and thereby protects the elbow material.

Impaction is the primary particle collection mechanism in venturi scrubbers. The effectiveness of impaction is related to the square of the particle diameter and the difference in velocities of the liquor droplets and the particles. The importance of particle size distribution cannot be over-emphasized. For particles greater than 1 to 2 μm, impaction is highly effective, and penetration (emissions) is negligible. However, penetration of smaller particles, particularly those in the 0.1- to 0.5-μm range, is very high. Hazardous waste incinerators can generate substantial concentrations of particulate matter in this submicron range and these particles are difficult to remove from the exhaust gases.

(2) Performance Parameters for Venturi Scrubbers

In general, the overall particulate collection efficiency in a venturi scrubber system increases as the static pressure drop increases. The most sensitive performance parameter for venturis is the static pressure drop. The static pressure drop is a measure of the total amount of energy used in the scrubber to accelerate the gas stream, to atomize the liquor droplets, and to overcome friction. At high static pressure drops, the difference in the velocities of the droplets and the particles in the gas stream is high; also, a large number of small diameter droplets are formed. Both of these conditions favor particle impaction into water droplets.

Another important design and performance parameter is the liquid to gas (L/G) ratio. Many venturi scrubbers are designed for L/G ratios between 5 and 12 gal per thousand actual cubic feet (gal/Macf). At L/G ratios less than 3 gal/Macf, the liquid supply is inadequate to completely cover the venturi throat. L/G ratios above 10 gal/Macf are seldom justified because they do not increase performance but do increase operating costs. Typically, the L/G ratio has not been included as a permit condition for RCRA incinerators.

A scrubber is not an isolated piece of equipment. It is a system composed of a large number of individual components. Because incinerators produce fluctuating conditions of gas flow rate, gas temperature, particulate characteristics, and acid gas concentration, there are distinct advantages for scrubber systems that are able to make operational adjustments to compensate for the changes. A list of the major components of commercial scrubber systems includes the following:

- Venturi section
- Spray nozzles
- Liquor treatment equipment
- Gas stream demister
- Liquor recirculation tanks, pumps, and piping
- Alkaline addition equipment
- Fans, dampers, and bypass stacks
- Controllers for venturi throat area, caustic feed, makeup water, and temperature excursions

(3) Operating Problems for Venturi Scrubbers

Venturi scrubbers have been used to control emissions from a wide variety of industrial and incineration processes. Normal operating problems that reduce venturi performance have been derived from past experience and are noted below. The normal problems are associated with maintaining the required pressure drop level and liquid flow rate, along with solids buildup at the wet-dry interface.

Maintaining a specified pressure drop level (and continuously monitoring pressure drop) is a common permit requirement for venturi scrubbers. There are several possible causes for a venturi operating at a reduced pressure drop level. A problem can be caused by the adjustable throat being opened too far, and the result is a reduction in pressure drop and throat gas velocity. Reduced pressure drop levels can also be caused by a loss or reduction in the scrubber liquid supply. A drop in liquid flow rate can result from scaling and pluggage in the nozzles, pipes, or flowmeters. Pump failure or low liquid levels in the recirculation tank can also be responsible for a loss or reduction in the liquid supply. These problems are identifiable from routine record keeping and inspection, and can be resolved readily by maintenance.

The venturi throat can be damaged by erosion or abrasion caused by a high level of suspended solids in the recirculated scrubbing liquid. Reducing the suspended solids by increasing the blowdown rate in the system will help solve erosion problems. Corrosion of internal parts can also be a significant problem. Maintaining the pH of the scrubber liquid between 5.5 and 10 will help reduce corrosion problems.

Another common problem with venturi scrubbers is a solids buildup at the wet-dry interface. The wet-dry interface is the transition region where the gas stream changes from an unsaturated to a saturated condition. As the hot gas stream comes into contact with the scrubbing liquid to cool and saturate the gas stream, there is a tendency for the suspended particulate to accumulate on the walls. Scrubber design can help reduce the rate of solids buildup, but gradual accumulation of deposits will occur. Routine maintenance involving removal of this buildup is typically the only solution. Sometimes a reduction in the suspended solids content will reduce the rate of the buildup, but routine maintenance will still be required at less frequent intervals. Inspectors should check to verify if routine maintenance is performed in this area.

A properly designed venturi should have a quench system that presaturates the gas stream ahead of the venturi. Presaturation will reduce the buildup of solids and enhance the collection of fine particles. If saturation occurs in the venturi throat, some pollutants may condense after the throat, thus avoiding collection.

C-2-b. Packed Bed Scrubbers

(Note: Materials from EPA 1984, EPA 1982, Calvert, and Andersen 2000, Inc. were used in the following discussion.)

In a packed bed scrubber, gaseous pollutants, such as acid gas, are removed from the gas stream via contact with a caustic scrubbing liquid. This liquid is distributed over a bed of inert plastic or ceramic packing material, manufactured in various shapes to produce a high surface area for the liquid-gas contact area. The flue gas flows through the scrubber countercurrent to the liquid flow. The liquid leaving the scrubber is either recycled or passed on for further treatment, and the clean gas leaving the system may pass through a demister (for removal of moisture droplets) prior to exiting from a stack. A clear water wash can be applied to the demister to minimize plugging. A typical packed bed scrubber is shown in Figure II-11.

Packed bed scrubbers generally are used for acid gas removal. The large liquor surface area created as the liquor gradually passes over the packing material favors gas diffusion and absorption. Packed bed scrubbers are not effective as stand-alone scrubbers for collection of fine particulate matter (less than 2.5 μm) because the gas velocity through the bed(s) is relatively slow. However, some packed beds are effective for the removal of particle-laden droplets or charged particles when used as a downstream collector behind a venturi or an ionizing wet scrubber. Some packed bed towers are designed with a tangential entry and a cyclonic separator at the base of the tower to remove the entrained droplets.

Packed beds can be designed either vertically or horizontally. Regardless of the orientation of the bed, the liquor is sprayed from the top and flows downward across the bed. Proper liquor conditioning and distribution is important for efficient removal of gases. The static pressure drop is not a sensitive parameter for evaluation or inspection of performance.

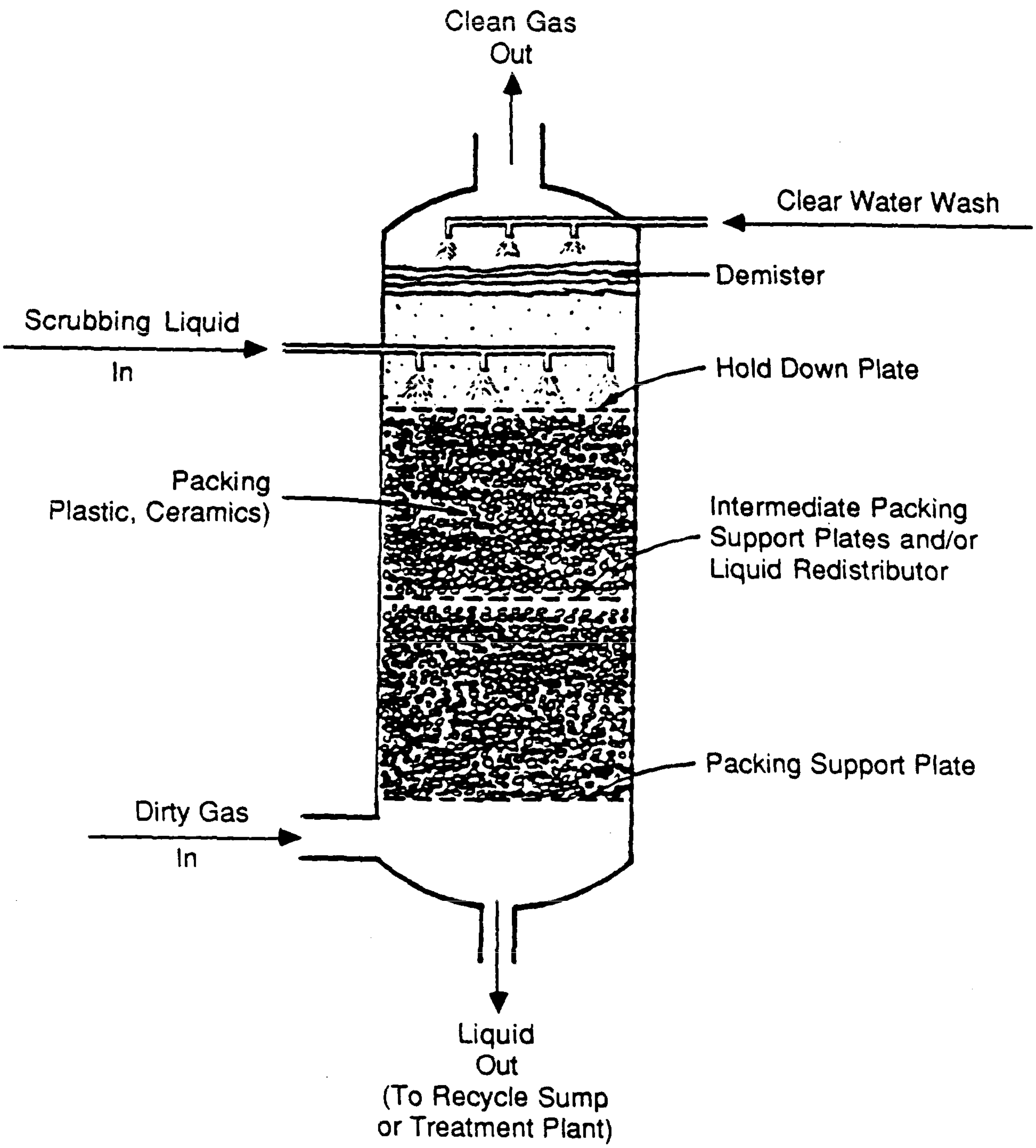


Figure II-11. Countercurrent packed bed scrubber.

(1) Operating Principles for Packed Bed Scrubbers

Absorption is the primary acid gas collection mechanism in packed bed scrubbers. The effectiveness of absorption in packed beds is related to the uniformity of the gas velocity distribution, the surface area of the packing material, and the amount and uniform distribution of scrubber liquid. The rate of HCl absorption is a gas film-controlled reaction, where the solubility of HCl in the liquid is an important factor.

Alkaline solutions such as sodium hydroxide (NaOH) or occasionally sodium carbonate (Na_2CO_3) are used with water to neutralize the absorbed acid gases in a packed bed scrubber. These two soluble alkali materials are preferred because they minimize the possibility of scale formation. For the case of using NaOH as the neutralizing agent, the HCl and SO_2 collected in the scrubber react with NaOH to produce sodium chloride (NaCl) and sodium sulfite (Na_2SO_3) in an aqueous solution.

(2) Operating Problems for Packed Bed Scrubbers

One common problem is partial or complete pluggage of the bed due to deposition of the solids collected and/or precipitation of solids formed by reaction of the neutralizing agent with acid gases. Another problem is settling of the packing material which leaves an opening at the top of the packed section. Both of these situations reduce the performance of the scrubber by disturbing the uniform flow of the liquid and gas streams.

Another common problem occurs when the pH of the scrubbing liquid routinely falls outside the normal range of 5.5 to 10. Corrosion and erosion of the packed bed vessel, gas ducts, and piping can occur when the scrubber liquid is not in the range for which the system was designed. (A specific minimum pH is often set in permits to assure adequate scrubbing capacity for acid gases and protection from corrosion damage.)

Maldistribution of the scrubber liquid is also a problem. Liquid maldistribution problems can be caused by misalignment or corrosion/abrasion/erosion of the spray nozzles or perforated pipes used for liquid distribution.

C-2-c. Ionizing Wet Scrubber

(Note: Materials from EPA 1979, EPA 1982, and Ceilcote were used in the following discussion.)

(1) Operating Principles for Ionizing Wet Scrubbers

Several ionizing wet scrubber (IWS) systems have been installed on RCRA incinerators because the IWS offers both particulate and gaseous pollutant control. More installations of this emerging control technology are in the planning and design review process. The IWS system consists of an ionizing section and a packed bed section. The ionizing section charges the particles for subsequent collection in the packed bed section, which is located immediately downstream of the ionizer. In addition to the normal components of a packed bed scrubber, the principle components of an IWS include:

- High voltage transformer-rectifier (T/R)
- Automatic voltage controller
- Ionizing wire-to-plate assembly
- Continuous spray system for ionizer plates and packed bed
- Intermittent spray system for ionizing wires

Figure II-12 presents a cross-sectional view of a single IWS module.

The IWS was developed to remove fine solid and/or liquid particulate down to 0.05 μ and less at low energy levels and high collection efficiencies. The IWS simultaneously removes acid gases from the process stream as well as coarse particulates. The IWS incorporates advantages of electrostatic precipitators and wet scrubbers within one device by combining the principles of electrostatic particle charging, image force attraction, agglomeration, and inertial impaction to increase particulate collection efficiencies in the submicron range.

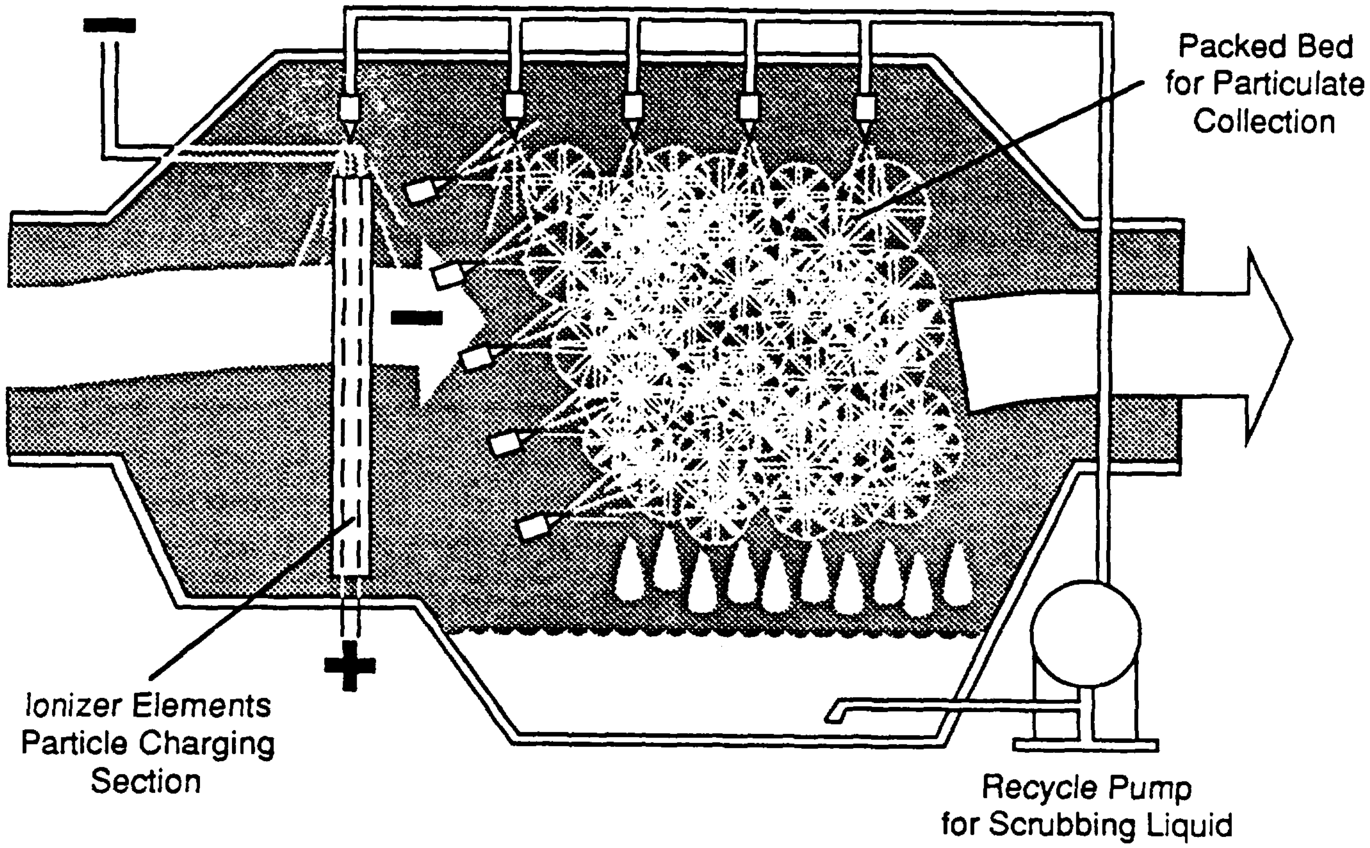


Figure II-12. Cross-section of ionizing wet scrubber (IWS).

A high voltage ionizer section is utilized to charge particles in the gas stream before entering a packed bed scrubbing section. Particulate matter is removed by inertial impaction or by the attraction of charged particulate to neutral packing surfaces within the wet scrubber section of the IWS. The collected particulate and gases are removed continually from the stream by a liquid scrubbing medium which flows vertically down through the packing.

For applications with high concentrations of particulate and gaseous pollutants, the IWS can be employed as a multistage un to increase collection efficiency. Actual field, laboratory, and operating experience indicate that two or three stages linked in series can solve most problems associated with submicron particulates requiring high collection efficiency.

The high voltage ionizing section electrostatically charges particles in the flue gas similar to an electrostatic precipitator. High voltage levels on the order of 30,000 volts or 30 kilovolts (kV) are designed to be delivered to the small diameter discharge wires to produce corona and ionization. Particles in the gas stream become charged by the ionization. Voltage levels in the range of 12 to 15 kV are necessary to initiate ionization and particle charging. Voltage levels below corona initiation do not effect any particle charging. In order to sustain the design performance levels, the manufacturer recommends that the IWS be serviced sufficiently to maintain a minimum voltage level of 25 kV. For a typical IWS unit, a reduction of 5 kV in the operating voltage level could result in the emission level doubling. For example, if an IWS were operating at 90% efficiency at full voltage, it would operate at 80% efficiency if the voltage were to drop off by 5 kV.

Spray systems are an integral part of an IWS unit. A flow of scrubbing liquid continuously cleans the plate surfaces to ensure adequate particle charging. A second spray system periodically rinses the wire-and-plate assembly, reducing the accumulation of residual solids. An adjustable timer is set to momentarily interrupt the high voltage at intervals of 1 to 10 hr for rinsing. The packed bed cross flow scrubber also has continuous sprays, and such operation has been described in the previous section on packed bed scrubbers.

(2) Operating Problems for Ionizing Wet Scrubbers

Common problems that reduce IWS performance are associated principally with the wire-and-plate assembly and are described below. Problems associated with the packed bed section are typical of those described in the packed bed section previously discussed. According to the manufacturer, the most common problems include improper alignment of the wire-and-plate assembly, wire breakage, scale (or solids) accumulation on the wires and plates, and scale accumulation on the high voltage insulators. The recommended tolerance for maintaining the alignment or centering the wires between the plates is 1/16 in. Each of the above problems reduce the operating voltage level and/or increase the sparking rate and consequently reduce the performance level of an IWS unit.

C-3. Dry Scrubbers

(Note: Materials from EPA 1987, Sedman, and Kroll were used in the following discussion.)

Dry scrubbing is a general term referring to the dry residue resulting from a scrubber process to absorb pollutants in industrial gas streams. The three categories of dry scrubbers are: (1) a spray dryer absorber involving the atomization of a wet slurry, (2) a completely dry sy involving the injection of a dry sorbent, and (3) a combination spray dryer and dry injection system. This section will only describe the spray dryer absorber process because it is the most common on hazardous waste incinerators.

The principle components of a spray dryer absorber include:

- Reagent storage and feed equipment
- Slaker, agitator, and heater
- Mixing tank and feed tank
- Atomizer feed tank and atomizers
- Spray dryer absorber
- Solids discharge tank
- Pumps, valves, piping, and controllers
- Instruments for pH, flow, pressure, and temperature

Figure II-13 presents a flow diagram and the components of a spray dryer absorber system.

C-3-a. Operating Principles for Dry Scrubbers

An alkaline reagent, normally pebble lime (or hydrated lime) is stored in a silo and fed into a slaker where it is mixed with water to form a slurry containing 25% solids by weight. A small HWI unit may use hydrated lime to offset the high costs of the slaker. The slurry is then further diluted with water to a level containing 5% to 20% solids prior to being pumped to the atomizers.

There are two types of atomizers: (1) rotary atomizers, and (2) dual-fluid nozzles. Rotary atomizers typically consist of a motor with a step-up gearbox which provides the high rotational speed of 10,000 to 20,000 revolutions per minute (rpm) for the atomizer wheel. Centrifugal forces atomize the slurry into droplets ranging from 30 to 100 μm in diameter. Dual-fluid nozzles use 70 to 90 psig compressed air to atomize the slurry into droplets ranging from 70 to 200 μm. The spray cloud produced by the nozzle is narrower than that produced by the rotary atomizer and thereby requires a smaller diameter spray chamber. Figures II-14 and II-15 depict the rotary atomizer and dual-fluid nozzle designs, respectively.

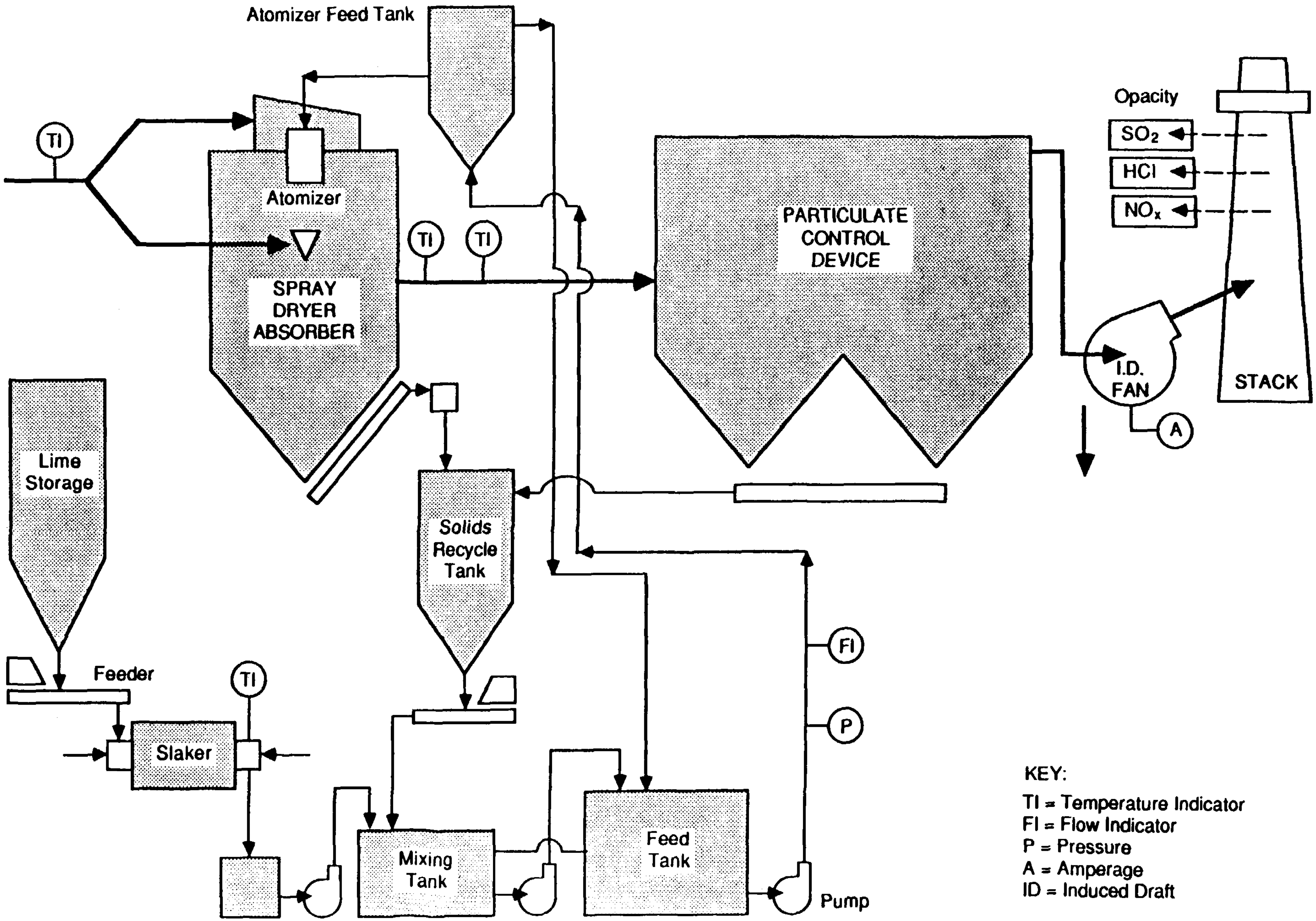


Figure II-13. Components of a spray dryer absorber system (Semiwet process).

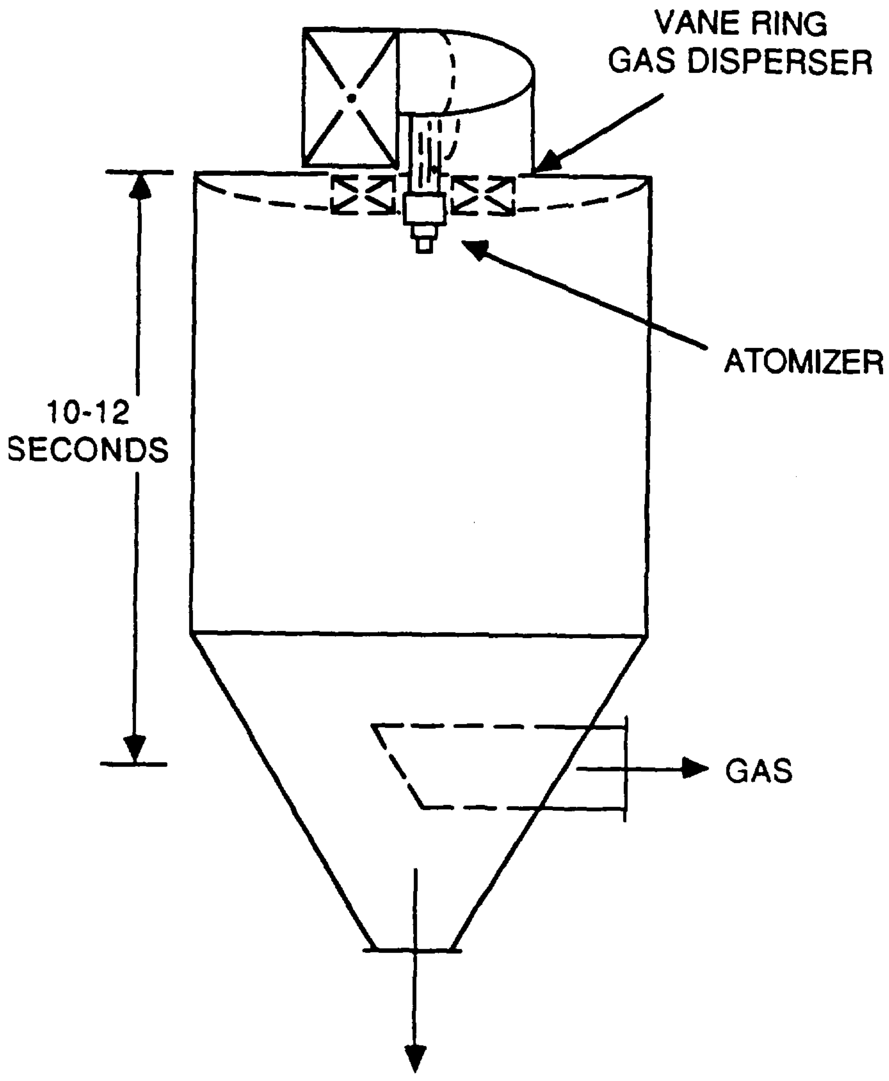


Figure II-14. Rotary atomizer dryer.

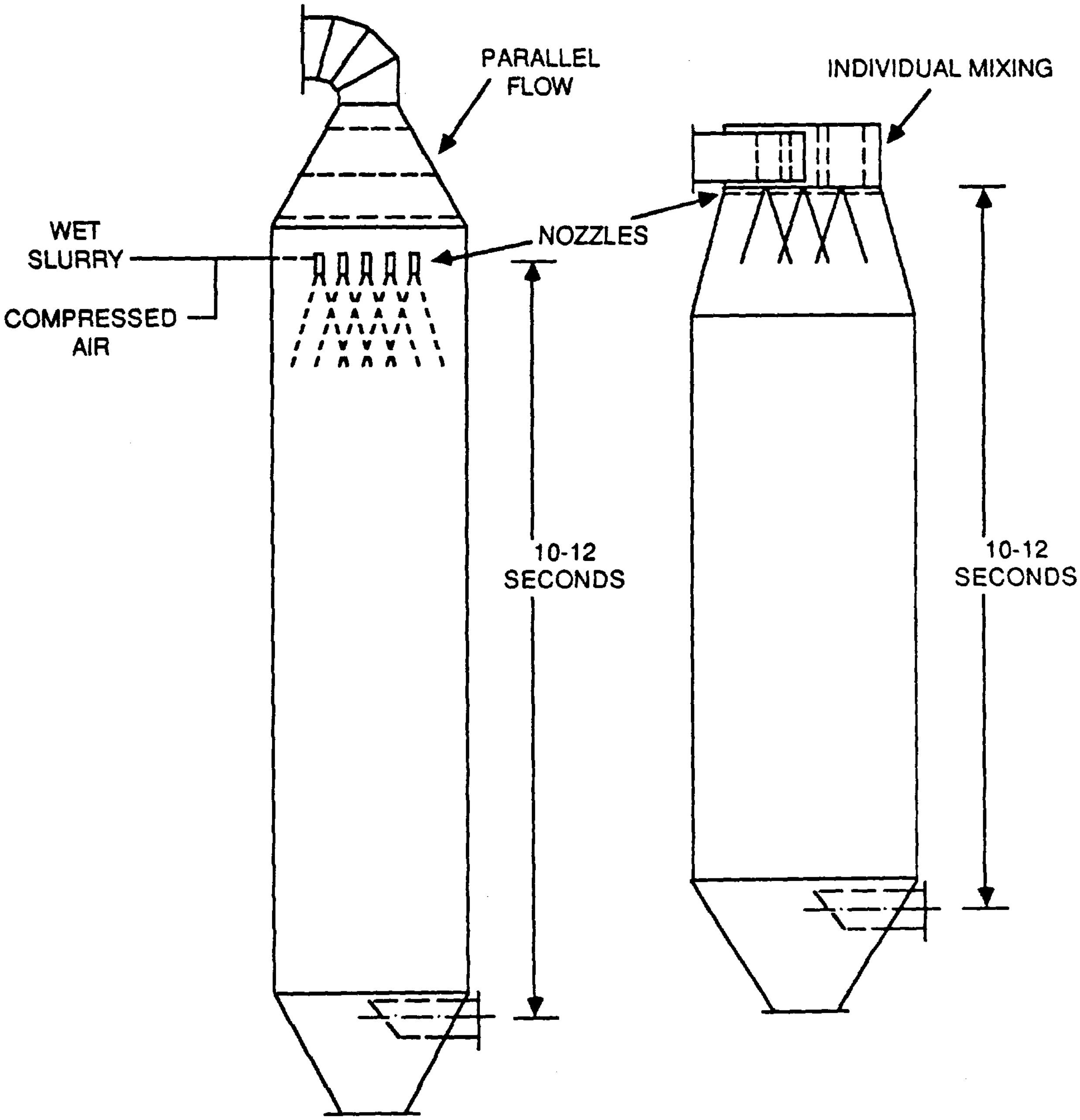


Figure II-15. Dual-fluid nozzle dryers.

The chamber where the slurry is atomized is called the spray dryer absorber (SDA), spray dryer chamber, or spray dryer reactor. Flue gas enters the SDA at temperature levels ranging from 450° to 2000°F. The spray cloud produced in the SDA cools and humidifies the flue gas along with absorbing the acid gases. Treated flue gas exits the SDA at temperatures ranging from 250° to 400°F, which is typically 90° to 180°F above the saturation temperature. A gas residence time in the SDA of 10 to 12 sec must be provided to allow acid gas to be absorbed into the droplets. The chemical reactions involving the acid gases (HCl, SO_2) and the lime-based slurry in the SDA are the following:

$$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$$
$$Ca(OH)_2 + SO_2 \rightarrow CaSO_3 + H_2O$$
$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$$

Other halides (such as HF) if present are involved in similar reactions.

The SDA has a cyclonic design to remove the large particles or solids entering or formed in the SDA. The dried solids are collected from heated hoppers below the SDA and consist of calcium chloride ($CaCl_2$), unreacted lime, and incinerator fly ash. These residuals must be managed as hazardous wastes if "derived from" the incineration of listed hazardous wastes or if they exhibit any hazardous waste characteristics.

Some spray dryers have problems with incompletely dried particulate sticking to the walls. Some spray dryers are designed to remove larger particles by gravitational settling, thus reducing the likelihood of wet particles sticking to the walls.

Spray dryer performance parameters involve several incinerator flue gas characteristics, including:

- Inlet gas temperature
- Outlet gas temperature
- Acid gas concentration (HCl, SO_2)
- Moisture concentration
- Particulate concentration

Spray dryer operating conditions that can be considered performance parameters include:

- Reagent feed rate
- Slaker (if any) exit temperature
- Mixing tank discharge rate
- Feed tank discharge rate, pressure, pH, solids content
- Atomizer feed rate
- Atomizer operating characteristics
  - (dual-fluid nozzle)--air pressure and flow rate
  - (rotary atomizer)--motor power and atomizer wheel speed (rpm)

Figure II-16 presents a schematic of a slurry flow controller system using incinerator load level and HCl effluent concentration as feedback signals.

A fabric filter system is typically installed downstream of the SDA. The fabric filter collects the small entrained particulate exiting the SDA, and provides some additional acid gas removal. The unreacted lime entrained in the SDA exhaust stream forms part of the cake on the bag surface, allowing an additional 15% to 20% of the acid gas to be removed by the fabric filter. More information on fabric filters is presented in the following section.

C-3-b. Operating Problems for Dry Scrubbers

Although little information is available on operating problems of dry scrubber on RCRA incinerators, some information has been compiled from dry scrubber experience on municipal waste incinerators.

Scaling and pluggage of the slurry feed line to the atomizer have been reported to be common problems. Severe scaling of the line occurs because of the relatively high pH of the slurry. The liquid flow rate of the slurry to the atomizer is monitored usually by a magnetic flowmeter

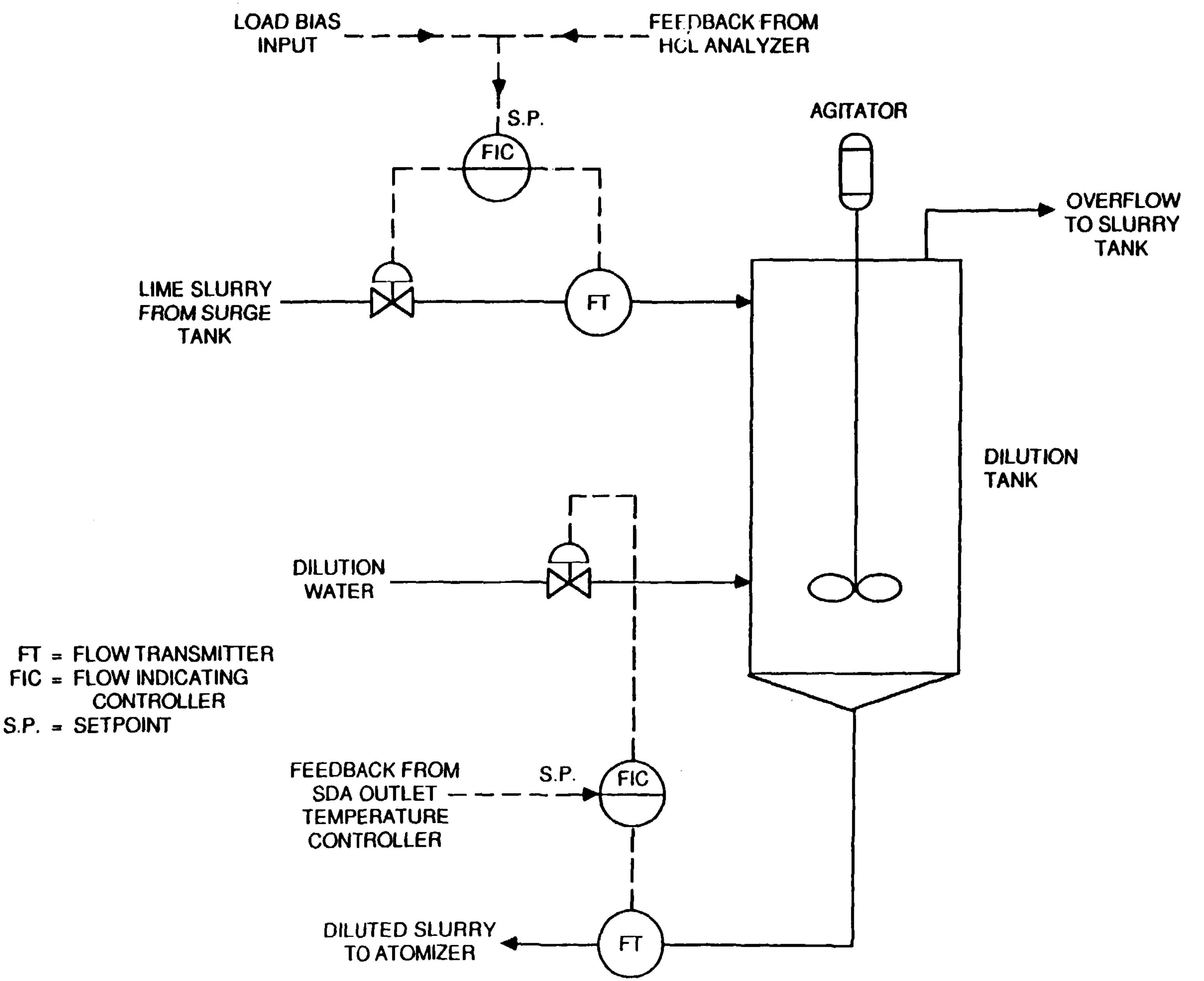


Figure II-16. Slurry flow control system.

or another type of an internal flowmeter such as an orifice. These meters are also vulnerable to scaling since the flow sensing elements are installed within the pipe. This problem can be reduced by designing the lines to be (1) well sloped with a minimum number of sharp bends, (2) not to be adjacent to high temperature equipment, and (3) capable of being flushed conveniently after outages.

Both the rotary and dual-fluid nozzle atomization equipment use abrasion-resistant, expensive, and replaceable inserts to withstand the wear caused by the action of the high velocity slurry stream. The performance of the atomizers and consequently the dry scrubber is sensitive to these replaceable inserts.

Corrosion can eventually present major problems for dry scrubbers because of the corrosive nature of calcium chloride and hydrogen chloride.

The lime and atomizer feed preparation systems handle slurries with high solids concentration. Settling of the solids will eventually lead to accumulation and pluggage of the handling equipment. In particular, screens or strainers need to be checked and cleaned frequently to minimize pluggage problems.

C-4. Fabric Filters

(Note: Materials from EPA 1982, EPA 1987, Sedman, Kroll, and Roeck were used in this compilation of information on fabric filters.)

Fabric filters have been used on a limited number of hazardous waste incinerators to control particulate matter emissions. Fabric filters are being used as stand-alone air pollution control devices as well as downstream collectors following dry scrubbers. They have some advantages over wet scrubbers in that they are highly efficient at removing fine particles if they are properly operated and maintained. However, their performance can deteriorate rapidly in situations where poor operation and maintenance result in improper bag cleaning, bag blinding, bag corrosion, or bag erosion.

Generally, fabric filters are classified by the type of cleaning mechanism that is used to remove the dust from the bags. The three types of units are mechanical shakers, reverse air, and pulse jet. To date, most hazardous waste incinerators that have been identified as having fabric filters use pulse jet units. The paragraphs below briefly describe the design and operating characteristics of pulse jet filters and identify key design parameters.

C-4-a. Operating Principles for Fabric Filters

A schematic of a pulse jet filter is shown in Figure II-17. Bags in the baghouse compartment are supported internally by cages or rings. Bags are held firmly in place at the top by clasps and have an enclosed bottom (usually a metal cap). Dust-laden gas is filtered through the bag, depositing dust on the outside surface of the bag. The deposited dust forms a porous layering on the bag that is referred to as the dust cake or filter cake. The bag acts as a support for the dust cake and allows the dust cake to become the filtering medium.

The dust cake is removed from the bag by a blast of compressed air injected into the top of the bag tube. The blast of high pressure air stops the normal flow of air through the filter. The air blast develops into a standing or shock wave that causes the bag to flex or expand as the shock wave travels down the bag tube. As the bag flexes, the cake fractures and deposited particles are discharged from the bag.

The blast of compressed air must be strong enough for the shock wave to travel the length of the bag and shatter or crack the dust cake. Pulse jet units use air supplies from a common header which typically feeds into a nozzle located above each bag. In most baghouse designs, a venturi sealed at the top of each bag is used to create a large enough pulse to travel down and up the bag. (Some baghouses operate with only the compressed air manifold above each bag.) The pressures involved are commonly between 60 and 100 psig.

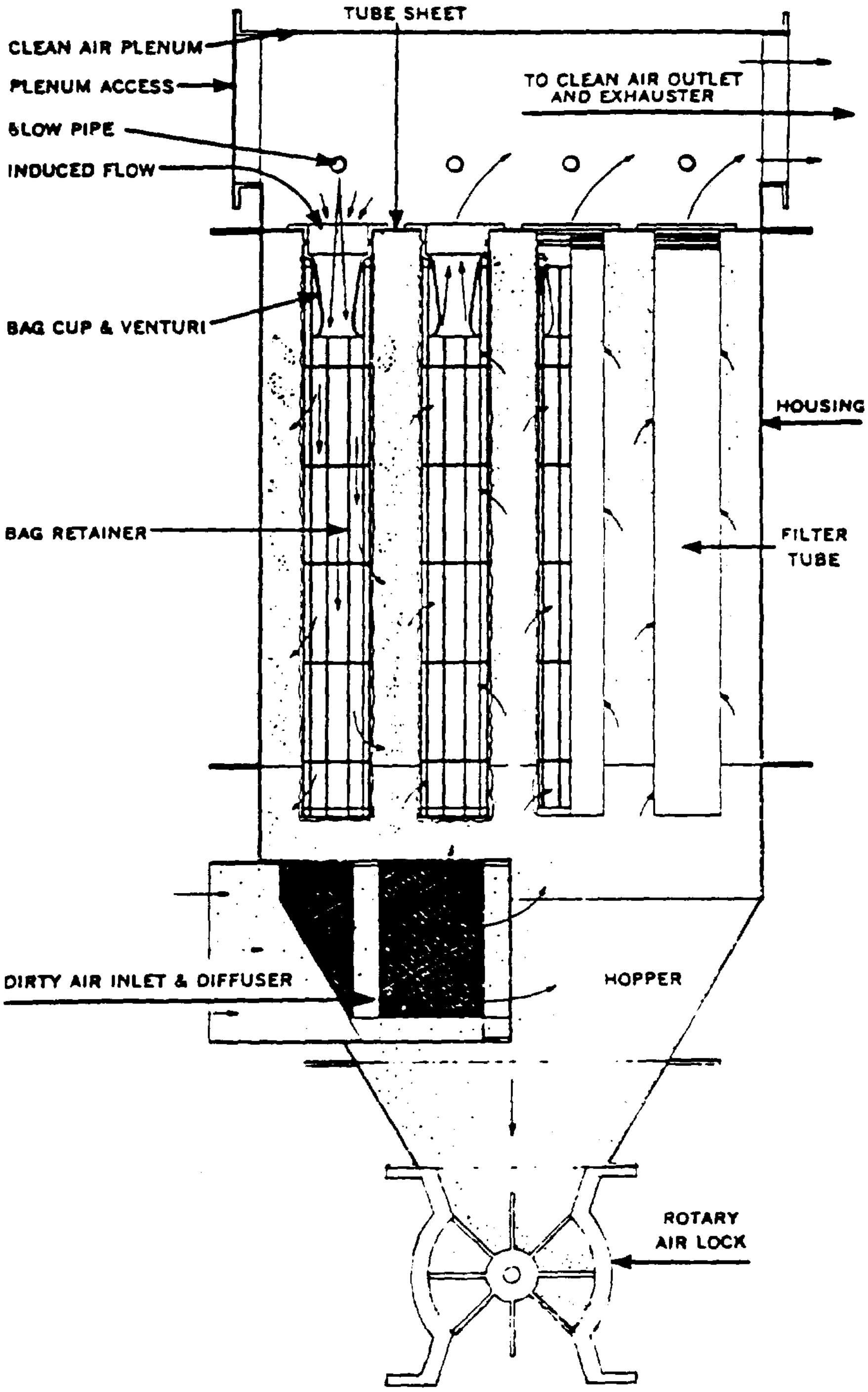


Figure II-17. Pulse jet baghouse.

Most pulse jet filters use bag tubes that are 10 to 15 cm (4 to 6 in) in diameter. Typically, the bags are 3.0 to 3.7 m (10 to 12 ft) long, but they can be as long as 7.6 m (25 ft). Generally, these bags are arranged in rows, and the bags are cleaned one row at a time in sequence. Cleaning can be initiated by a bag pressure drop level, or it may occur on a timed sequence.

C-4-b. Performance Parameters for a Fabric Filter

The key design performance parameters for a pulse jet filter are the air-to-cloth ratio, the bag material, and gas temperature. The key operating parameters include gas temperature, pressure drop, bag cleaning pressure, and bag cleaning cycle.

The air-to-cloth ratio is actually a measure of the superficial gas velocity through the filter medium. It is a ratio of the flow rate of gas through the fabric filter to the area of the bags and is usually presented in units of acfm/ft^2 or ft/min. Generally, the air-to-cloth ratio on HWI units is in the range of 1 to 5 ft/min.

Bag material (various types of synthetic fibers, sometimes with special coatings) generally is based on prior experience of the fabric filter vendor from a similar application. Key factors that are considered are: cleaning method, abrasiveness of the particulate matter and abrasion resistance of the material, expected operating temperature, potential chemical degradation problems, and cost. To date, little information has been obtained on types of material typically used for hazardous waste incinerator applications.

The operating temperature range of the fabric filter is of critical importance for various reasons. Since the exhaust gas will contain moisture and may contain HCl, the unit should be operated at sufficiently high temperatures to assure that no surfaces drop below the water or acid dew points. Condensation of water will cause a condition where the bags are blinded by the wet particulate resulting in excessive pressure drop levels. Condensation of HCl will result in corrosion of the housing or bags, and may also cause bag blinding. Gas temperatures should be maintained at about 150°C (300°F) to ensure that no surfaces are cooled below the dew point. The site-specific dew point is determined by the content of H_2O, HCl, and SO_3 in the gas stream. Above a maximum temperature that is dependent on filter type, bags will degrade or in some cases fail completely. Gas temperatures should be kept safely below the allowed maximum.

Pressure drop in fabric filters generally is maintained within a narrow range. For pulse jet filters the typical range is 3 to 8 inches water column (in w.c.). Pressure drops below the minimum indicate that either: (1) leaks have developed, or (2) excessive cleaning is removing the base cake from the bags. Either phenomena results in reduced performance. Pressure drops greater than the maximum indicate that either (1) bags are "blinding," or (2) excessive cake is building on the bags because of insufficient cleaning. A problem that typically results from excessive pressure drop is reduced flow through the system.

C-4-c. Operating Problems with Fabric Filters

The two main indicators of operational problems associated with fabric filters are high opacity and high pressure drop. Well designed, operated, and maintained fabric filters will generally have a very low opacity (between 0% to 5%), and the pressure drop will fall within a general operating range for the particular fabric filter type (3 to 8 in w.c. for pulse jet fabric filters). Opacity and/or pressure drop deviations from the trial burn levels are indicators of fabric filter performance deterioration. Higher or lower than normal inlet temperatures can cause opacity and pressure drop problems. The inlet temperature should be monitored continuously.

Although not specifically required by RCRA, opacity measurements can be useful in determining trends in the performance of the fabric filter. Opacity can be measured by an optical-based instrument installed across the stack. Typically, the opacity level of a properly operated and maintained filter will be very low, except when a condensible plume is present during severe weather conditions. In general, high opacity is a good indicator of fabric failure. A consistently elevated opacity level is an indication of major leaks and tears in the filter bags. A puffing, intermittent opacity observed after cleaning is a good indication of pinhole bag leaks or over-cleaning. The factors that cause fabric failure include improper filter bag installation, high temperature, chemical degradation, and bag abrasion.

Internal inspection of the unit conducted by trained personnel will clarify the nature of any major problems. Visual observations will determine the occurrence of improper bag installations, pinhole leaks, bag tears, bag blinding, and bag cleaning system anomalies. Use of commercially available fluorescent dye and an ultraviolet light during internal inspections will identify the specific bags with pinhole leaks, tears, and any seal leaks due to improper bag installation.

Improper installation of filter bags can result in leaks around seals, improper bag tensioning, and damage to the bags. Lack of training of maintenance personnel in filter bag replacement and poor access to the fabric filter housing are contributing factors to improper installation.

High temperatures are the result of process malfunction(s) upstream of the fabric filter. Therefore, in the fabric filter design phase, a fabric must be chosen on the basis of expected temperature range with an adequate margin of error. In general, high temperatures shorten bag life considerably. High temperature breaks the polymer chains in most commercially available fabrics causing loss of strength and reduced bag life. High temperature attacks the finish on fiberglass bags causing increased bag abrasion. Temperatures that are high enough can cause filter bags to ignite. Some installations have an alarm system to warn of high temperature excursion or automatic waste cutoff required by the operating permit to prevent damage to the filter bags. Inspectors should verify in the facility's records that waste feed to the incinerator was shut off during any period that the baghouse was bypassed because of high temperature excursion, and should note the number and circumstances of any such bypasses.

Filter bag abrasion can be caused by contact between a bag and another surface (e.g., another bag or the walls of the fabric filter) or by the impact of higher-than-average gas volumes and particulate loading on the bags. Bag abrasion can also be a problem when the fabric filter experiences a high pressure drop.

Condensation of moisture on filter bags is caused by temperatures in the fabric filter below the dew point and reduces the porosity of the filter cake. "Mudding" or blinding of the bags increases the resistance to flow and occurs because the cleaning system cannot remove the dust. Condensation can be prevented by preheating the fabric filter during the startup operation and by purging moist gases from the unit prior to shutdown. During operation it is critical to maintain the operating temperature above the dew point of the gas stream at all times and in all localized areas.

Cleaning system failures in pulse jet systems are usually the result of worn or undersized compressors, moisture or oil contamination in the pressurized lines, and failed solenoids and/or timers. Compressor problems are indicated by a low compressed-air pressure. Because of the low pressure, the system cannot clean the bags properly. An increased pressure drop across the fabric filter results due to dust cake buildup. Compressor capacity may be a problem and should be checked against the needs of other systems that the compressor serves. Routine preventive maintenance can prevent premature failure of the compressor and can prevent worn compressor seals from passing oil into the filter bags. Both reduced compressed-air pressure and bag blinding can cause an increase in pressure drop. Failure of solenoids and/or timers can prevent the filter bags from being cleaned at all. These systems require clean, dry mountings to operate properly. Solenoid failures affect the only row of filter bags that the solenoid services, while timer failures tend to affect most, if not all, of the fabric filter system.

An additional problem is associated with the pulse pipe that discharges the compressed air into the bags. Pulse pipes may be damaged by the force of the compressed air. Consequences are ineffective cleaning and pressure drop increase, improper pipe alignment that may blow holes in the filter bags, or a loose pipe that may damage the interior of the fabric filter. The sound of a loose pulse pipe is unmistakable because it moves whenever compressed air is fired into the pipe.

An <u>increase in pressure drop</u> may indicate operation and maintenance problems that may be corrected. However, blinded bags resulting from condensation or the accidental discharge of compressor oil into the fabric filter will likely have to be replaced. An increase in pressure drop can be prevented by the following:

- Preheat the fabric filter prior to process operation.
- Purge the fabric filter of moist air prior to shutdown.
- Always maintain the temperature of the gas entering the fabric filter above its dew point.
- Perform preventive maintenance of the compressor system and solenoid/timer system.
- Make necessary repairs to pulse pipes as required.

D. PROCESS AND EMISSIONS MONITORING INSTRUMENTATION

Proper operation of incinerators depends to a large extent on certain operating parameters that are commonly used to monitor the process and/or to provide automatic control of process parameters. Inspectors will review the monitored values and will check the effectiveness of the monitors as important elements of an incinerator inspection. Basic parameters include:

- Temperature
- Pressure
- Oxygen
- CO
- Waste feed rate
- Combustion gas velocity and airflow

Other parameters are monitored depending on specific situations and needs. (The importance of these parameters in indicating adequate performance of an incinerator is discussed in Chapter III.)

RCRA incinerators are required to be equipped with a system to automatically shut off the flow of waste feed into the incinerator whenever certain key operating conditions (e.g., temperature, combustion, gas velocity) deviate from allowable levels. The automatic waste feed cutoff system includes sensing devices (for each key condition), transmitters that send the signals (i.e., reading) from sensing devices: A receiver/signal processor that evaluates the signals and sends a cutoff signal when limits are exceeded; and a cutoff device (e.g., a switch, valve, etc.) that effectively shuts down the flow of waste materials going into the incinerator.

More information on automatic waste feed cutoff systems and the operating parameters that trigger its use is presented in Chapters III and IV of this manual.

These key parameters are listed below and accompanied by descriptions of the typical instrumentation used to monitor/control them, and a brief discussion of its proper use and operation.

D-1. Temperature

Typically, thermocouples are used to monitor temperatures in the combustion chambers and the air pollution control system. The thermocouples are always enclosed in a thermowell to protect the small thermocouple wires and the critical thermocouple junction from direct exposure to the combustion gases and entrained dust particles. Thermocouples are usually located near the exit of the combustion chamber in order to provide a representative temperature reading away from the flame zone, which can otherwise cause erratic temperature readings as well as damage to the thermocouple. Generally, thermocouples also are located upstream from the air pollution control system to provide a warning or control mechanism for high temperature excursions that could damage control equipment.

Although thermocouples typically are very reliable, they can fail or give erroneous readings. For example, the thermocouple junction or wire may break after long exposure to high temperatures; typically dual thermocouples are used in close proximity to one another in the incinerator chamber to compensate for these failures. However, a thermocouple can give erroneous readings for reasons that are not as obvious as a broken junction or wire such as recrystallization or contamination of the wires.

Dual thermocouples allow a comparison of readings to identify a faulty thermocouple. The second thermocouple enables continued monitoring of temperatures while the faulty thermocouple is being checked or replaced. Failure of a thermocouple junction would result in automatic waste feed cutoff because of a temperature signal that would be below the permitted minimum temperature.

The best maintenance procedure for thermocouple is periodic replacement and routine checking of the thermowell for physical integrity and any outer dust buildup. Because it is not practical to perform a high temperature calibration of the thermocouple, only periodic replacement ensures a properly operating thermocouple is in place. Inspectors should check to see if the thermocouples are periodically replaced.

Close monitoring of temperatures is essential to good incinerator operation. It is necessary, therefore, to identify possible thermocouple problems because the temperature signal is usually the primary measurement used for automatic control of auxiliary fuel burners and combustion air flow.

D-2. Pressure

Combustion chamber pressure values can be measured in units of gauge static pressure, but it is actually a measure of the differential pressure (ΔP) between the inside of the chamber and the outside air. Monitoring of ΔP can be done with a common U-tube manometer, but for incineration systems, a differential pressure transmitter typically is used. All of these instruments use the same basic method to monitor incinerator draft. One side (the high-pressure side) of the instrument is always open to the ambient air; the other (low-pressure) side is connected by tubing or piping to the incinerator.

These types of monitors also are used to measure differential pressure across air pollution control systems. The low-pressure side is connected to a pressure tap in the ductwork downstream from the control device, and the high-pressure side is connected upstream from the control device.

A differential pressure transmitter contains a diaphragm with two tubes connected on each side of the diaphragm; the diaphragm moves or deflects as a result of changes in pressure. The transmitter is designed so that any change or deflection causes a change in an electrical output signal from the transmitter. The electrical signal is sent to the monitor in the control room that indicates the incinerator pressure or the pressure differential across the control system.

Faulty pressure readings can be caused by damage to the sensor or to other components of the system. Transmitters used to measure ΔP are sensitive devices that can be damaged by excessive vibration or sudden shocks. The tubing and its connections may also experience problems such as pluggage due to the severe environmental conditions within the combustor or APC system. Over time, tubing or piping is degraded by sunlight and temperature changes. This degradation leads to leakage, which results in erroneous readings, and ultimately system failure. Specific calibration requirements may be defined in a permit to address these concerns, and inspectors should review these procedures to ascertain whether the requirements are being met.

D-3. Oxygen Concentration

Although not required by RCRA regulations, many incinerators are equipped with oxygen analyzers to monitor the oxygen concentration in the combustion gases from the combustion chamber. In some incinerators, the oxygen levels measured by the monitor are used to moderate air feed rates to control of the combustion process. The data from the oxygen monitor also can be used to continuously correct the CO concentration value (produced by a CO monitor) to a 7% oxygen basis.

Oxygen monitors, like the CO monitors discussed later, may be of two types: in situ or extractive. In situ merely means that the analyzer's sensor is mounted in direct contact with the gas stream. In an extractive system, the gas sample is continuously withdrawn (extracted) from the gas stream and directed to the analyzer, which may be located from several feet to several hundred feet away. The monitor point may be in the stack, at the combustion chamber exit, or at other locations within the process (e.g., duct between air pollution control system and the stack). These two types of sampling system are illustrated in Figure II-18.

- In Situ Oxygen Analyzers provide rapid response to changes in the oxygen content of the gas because the sensor is in direct contact with the gas stream. Most in situ oxygen analyzers are equipped with connections so that zero gas (nitrogen) or calibration gas (air) can be flushed through the permeation tube and in contact with the

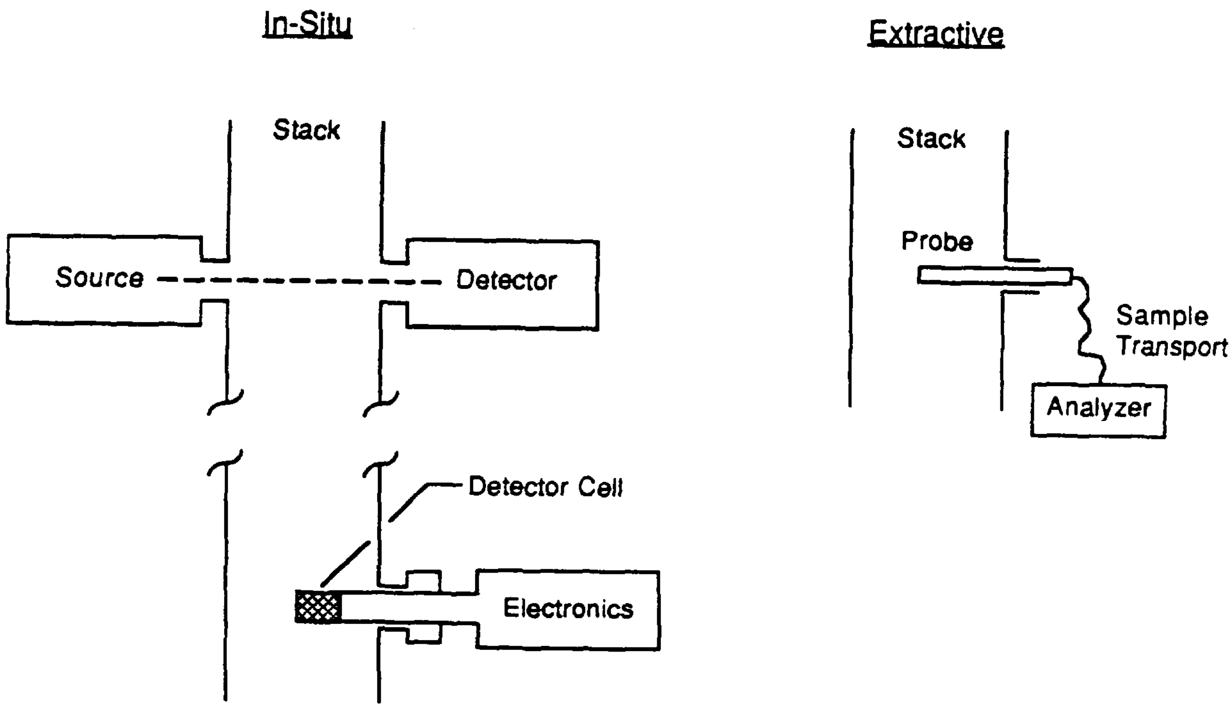


Figure II-18. In situ versus extractive sampling systems.

sensing element. Flushing provides a means of zeroing and spanning the analyzer, and also creates reverse flow of gas through the permeable tube that helps to remove dust particles that eventually will clog the tube and slow the detector's response time. Even so, the tube periodically must be removed for cleaning or replaced if warranted. Manufacturers recommend that the sensing element be replaced after several months of service.

- Extractive Oxygen Analyzers continuously withdraw a sample of gas to the actual analyzer and include a "conditioning system" for removal of water, dust, and sometimes other constituents that would interfere with operation of the analyzer. An example extractive system is illustrated in Figure II-19. Shown are the moisture knockout for removal of water vapor and the normal connections for zeroing and calibrating the analyzer. Calibration gas should be injected as close as possible to the stack probe and at or very near atmospheric pressure.

  The integrity of the sample line and the conditioning system is crucial to obtaining a representative sample for accurate results. Calibration is performed by zeroing with an inert gas such as nitrogen (N_2) and checking span with a gas of known oxygen concentration. Span values, calibration drift, etc., may be included as performance specifications in the permit. Oxygen analyzers are highly accurate as long as the actual gas to be sampled reaches the analyzer (i.e., no pluggage or in-leakage of air occurs), the conditioning system, is operating properly, and the instrument is calibrated.

  Problems with oxygen analyzer systems may be difficult to discern since they commonly are associated with slowly developing pluggage in the system or small air in-leaks. The extractive systems should be checked daily by the operator, and maintained and calibrated on a weekly basis by the incinerator instrument personnel. Requirements are typically specified in the permit; inspectors will be reviewing the facility's response to these requirements during the inspection.

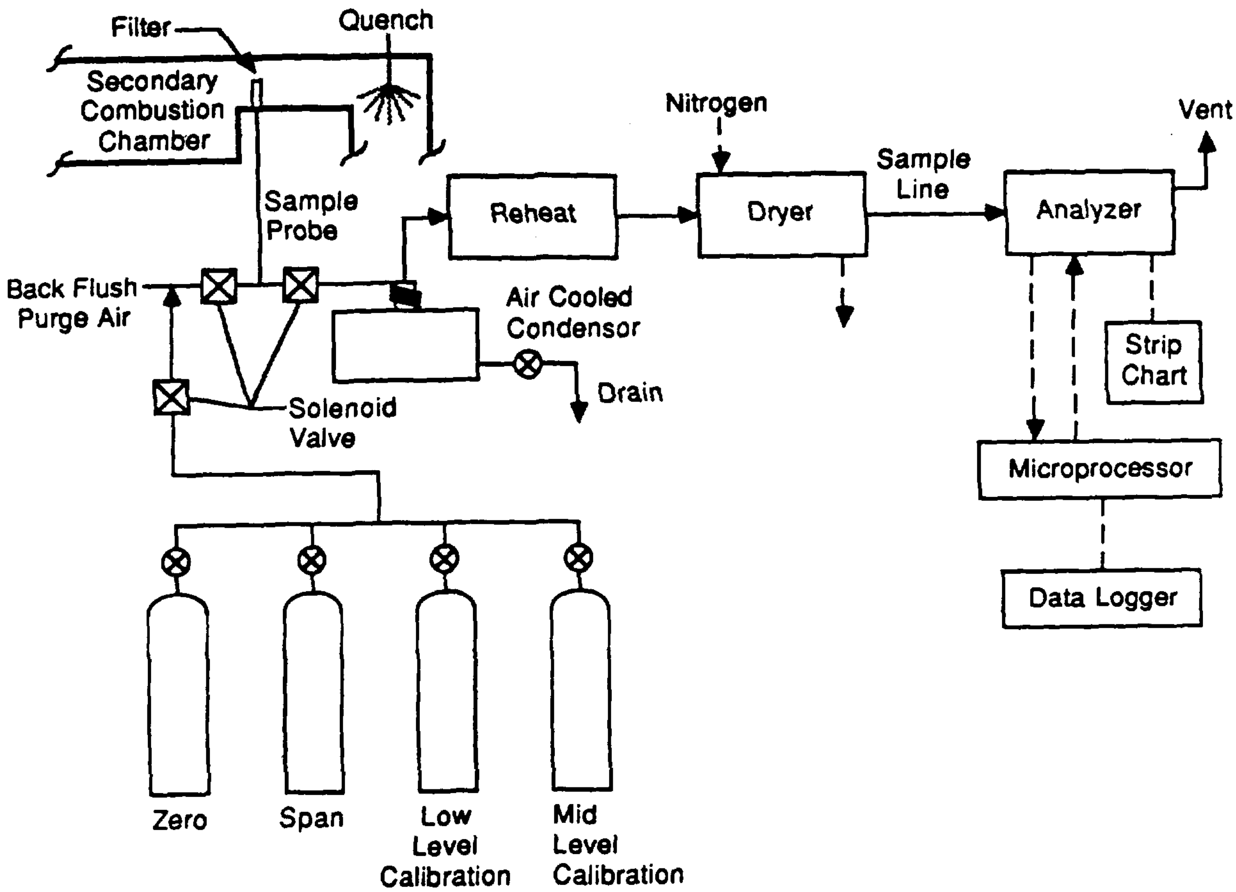


Figure II-19. Example extractive system.

D-4. Carbon Monoxide

Continuous monitoring of carbon monoxide (CO) emissions is required by RCRA regulations to ensure that proper combustion conditions are maintained and to minimize emissions of products of incomplete combustion. Carbon monoxide analyzers typically are not part of the automatic process control system, but they are tied to the automatic waste feed cutoff system. In general, high CO levels indicate some other problem in the process and its control system (e.g., feed rate or temperature); low CO levels tend to indicate proper combustion conditions.

Location of the CO sampling point may vary, although it is most commonly in the stack or at the exit of the combustion chamber. As with oxygen monitors, CO analyzers can be affected upstream in-leakage of air, but the relative error is usually less than with oxygen monitors. The permit will normally require that the CO reading be corrected to 7% oxygen so that factors such as in-leakage will not affect the CO reading.

Carbon monoxide analyzers also may be in situ or extractive, but by far the most common type is extractive.

<u>In situ CO monitors</u> use an infrared signal that is transmitted across the duct or stack to a receiver or reflector on the opposite side. The change in the signal is processed by the analyzer system, and an output signal as an equivalent CO concentration is provided. In situ CO monitors are difficult to calibrate directly because the duct cannot be filled with a gas of known concentration. Therefore, calibration is performed using an optical filter that can be moved into the signal path, or a calibration gas that can be put through a separate cell through which the infrared signal can be sent. In most cases, in situ systems are installed in the stack after pollution control devices have removed most of the particulate matter.

Much of the previous discussion on extractive oxygen systems also applied to <u>extractive CO systems</u>. In fact, the same extraction/conditioning system often is used for both monitors. With both gases, plugging or in-leakage of air into the sample line is a more likely cause of problems than the analyzer itself. However, for extractive CO analyzers removal of the water vapor is of more importance. Therefore, daily checks of the conditioning system should be made by the operator, with weekly maintenance and calibration by the instrument personnel. EPA has developed draft performance specifications for CO and O_2 monitors installed on hazardous waste incinerators permitted under RCRA. These or other specifications may be included in the permit. (Information is provided in EPA 1989b.)

D-5. Waste Feed Rate

The waste feed rate to an incinerator can be monitored in a variety of ways, depending upon the types of feeds encountered. The feeds may be free-flowing liquids, gases, solids, or sludges.

D-5-a. Liquid Feeds

Typical flowmeters used to monitor the liquid waste feed rate to incinerators are detailed below. The five basic types include those that (1) measure velocity or flow rate indirectly via measuring pressure differential across a restriction (differential pressure meters), (2) measure velocity (velocity meters), (3) measure mass flow, (4) positive displacement meters, and (5) level gauges.

Differential Pressure Meters

- Rotameter--This type of flowmeter is available for a wide range of liquid viscosities including some lightweight slurries. It is calibrated through using a fluid of known density.

- Orifice meter--This instrument is used with gases and low-viscosity fluids. It involves a hole in a thin, flat sheet or plate which is used to create a pressure head difference. Abrasive particles may erode the opening, and plugging may constrict the opening. Both factors affect accuracy of the meters.

- Venturi meter--A venturi meter is similar to an orifice meter, but uses a less severe obstruction in the shape of a converging and diverging core.

- Vortex shedding meter--This device is applicable to low-viscosity fluids and gases under turbulent flow conditions.

Velocity Meters

- Acoustic flowmeter--This meter uses a pair of transducers on either side of a pipe to transmit and receive high-frequency (ultrasonic) sound waves through the moving fluid. These meters are more commonly used for aqueous wastes (wastewater) than organic wastes.

- Magnetic flowmeter--In this type of meter, electricity is generated by moving a conducting medium (waste) through a magnetic field. The voltage generated is proportional to the velocity. Problems include interference from entrained gases, fouling of electrodes by "greasy" fluids, and electromagnetic interference from nearby electrical equipment.

Mass flowmeter--This instrument, also known as a Coriolis flowmeter, may be used with liquids of widely varying viscosity and density and most slurries. A U-shape tube is vibrated in a twisting motion at its natural frequency by a magnetic device. The amount of twist is proportional to the mass flow rate of the fluid flowing through the tube. The twist is measured by magnetic sensors and converted electrically into a mass flow rate.

Positive displacement meter--This type of flowmeter is highly accurate for viscous fluids. It cannot be used with multiphase liquids, gases, or slurries of varying density.

Level meters--Level gauges or meters may also be used to measure a change in the tank volume or mass of its contents. This method includes manual checks with a dipstick, and meter operating on mechanical, ultrasonic, nuclear, or radio frequency principle.

D-5-b. Gaseous Feeds

The best types of flowmeters for gases are the orifice meter and the vortex shedding meter, discussed above under liquid feeds.

D-5-c. Solid/Sludge Feeds

Commonly used flow meters are described below.

(1) Volumetric Methods

These methods include calibrated augers and pumps, rotary feeders, and belt conveyors. Most of these methods are based on a tachometer signal that indicates speed of the process equipment. This speed must be related to feed rate by performing calibration tests. These systems are generally calibrated by the user for each particular feed material.

(2) Level Indicators

This category encompasses a variety of methods based upon mechanical, ultrasonic, nuclear, and radio frequency principles of operation.

(3) Stationary Weight Indicators

These methods, which include weigh hoppers/bins and platform scales, determine the dead weight of material loaded into a hopper, bin, or container. After they are weighed, the contents are then batched into the process.

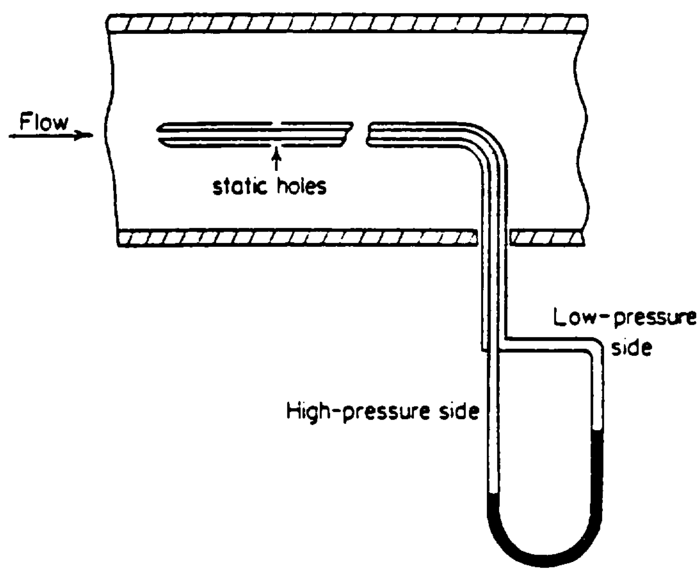
(4) Conveyor Weighing Systems

These methods include belt weighers, weigh belts/augers, and loss-in-weight feeders. All conveyor weighing systems are fairly similar in operation, mainly differing because of placement locations of the weighing device.

D-6. Combustion Gas Velocity and Airflow

Many incinerators include instrumentation to monitor the various input air streams (e.g., primary air and secondary air). All are required to have instrumentation for monitoring an indicator of the combustion gas velocity. Several types of instruments may be used to monitor gas flow, but the most common are pitot tubes or Annubar flowmeters (see Figures II-20 and II-21). Both of these monitors consist of two tubes in the air stream: one faces into the gas stream and is subject to velocity pressure; a second is used to measure static pressure of the gas in the duct. The difference between these two pressures provides a measure of the velocity or flow rate of the air in the duct.

<u>A pitot tube</u> provides velocity for only a single point in the gas stream. To obtain a complete velocity profile, a traverse of the duct that provides velocity readings in a variety of locations over the cross-section is required. An <u>Annubar</u> is a modified form of pitot tube designed to simulate a full velocity traverse, both simultaneously and continuously. The Annubar itself is a single tube which spans the entire duct. Holes are spaced along it in the same pattern as a pitot traverse. Impact gas enters the tube through these holes and mixes along the tube, thereby



Pitot-static tube.

Figure II-20. Schematic of pitot-static tube.

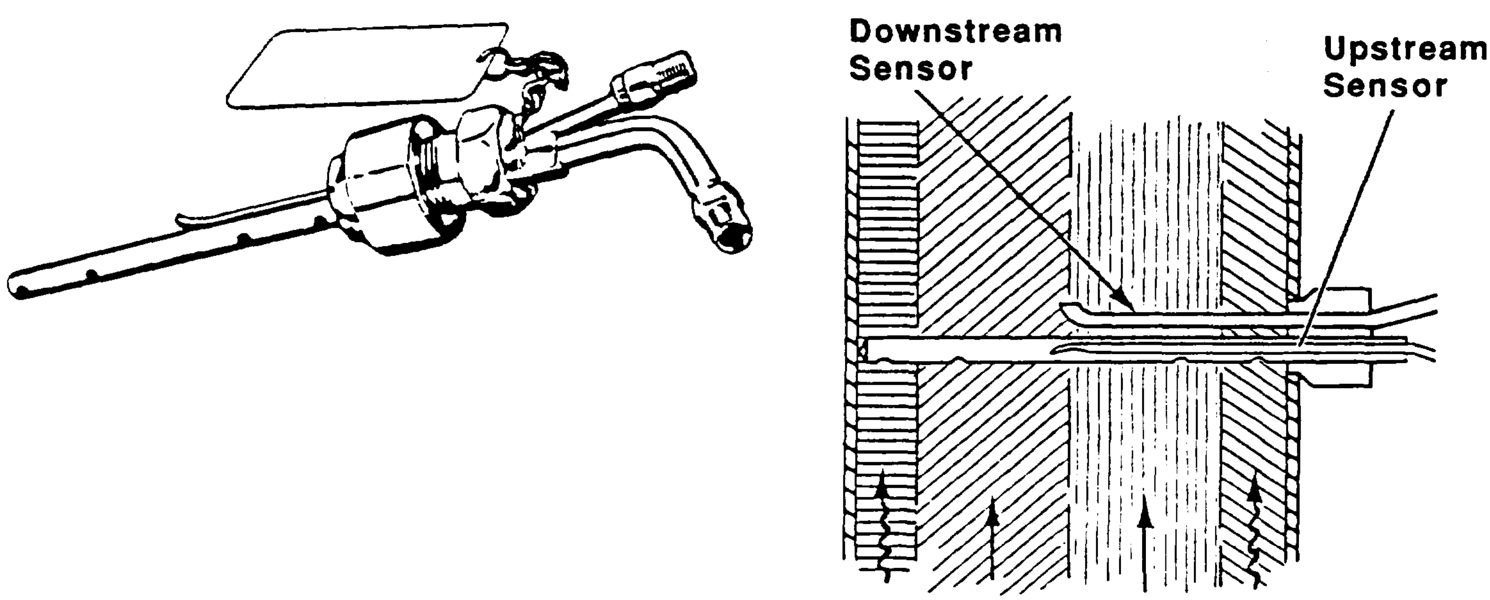


Figure II-21. Schematic of Annubar.

"averaging" the velocity pressure. As with pitot tubes, velocity is determined by comparing velocity pressure with the duct's static pressure. Calibration factors for pitot tubes and annubars can be determined prior to installation in a wind tunnel. Indirect monitoring of changes in the calibration factor of pitot tubes and annubars installed in an incinerator duct can be accomplished by monitoring pressure drop across the tubes. Potential problems with Annubars and pitot tubes are corrosion and particulate buildup over extended usage.

Two other types of flowmeters may be used--orifice plates and venturi tubes. Both types are again based upon measuring a differential pressure. An orifice plate is a thin-walled plate inserted into a pipe to constrict flow. Gas flow through an orifice in the plate of known diameter. Pressure readings are taken from taps located on either side of the plate. Comparison of the two pressures fixes the gas velocity as determined by pressure drop across the orifice. Problems occur when particulate matter erodes the plate. In addition, careful calibration of these devices is required for compressible fluids.

A venturi tube is a contracting flow tube with pressure taps straddling the smallest part, or throat, of the tube. Comparison of these pressures determines the flow rate through the tube. Overall, venturi tubes are less susceptible to fouling and corrosion than the other gas flow rate measurement method. Their accuracy depends primarily upon the pressure device and the calibration procedures.

Combustion gas flow measurement is typically performed at either of two locations: (1) between the combustion chamber and quench zone, or (2) in the stack. Exact location within these areas is chosen on a site-by-site basis according to availability of an adequate length of straight duct, expected gas temperatures, and access to the location.

In some incinerators, the indicator of combustion gas velocity is based upon an indirect monitoring method. Indirect methods may measure fan rotational speed, current draw, or excess O_2 levels.

D-7. pH Measurements

As discussed in the air pollution control section of this chapter, the pH of scrubbing liquid may be continuously monitored to allow control of potential corrosion problems. There are two types of pH sensors: Immersion (dip-type) and flow-through. The immersion sensor is merely inserted into a tank and can be removed for maintenance and calibration. A flow-through sensor depends upon a continuous flow in the sample line. The pH measurement probe consists of a pH measuring electrode, a reference electrode, and a high input impedence meter.

Calibration of a pH monitoring system is performed through the use of known pH buffer (reference) solutions. Typically, pH 7 is used for calibration, although pH 4 and pH 10 may also be used, depending upon the expected ranges of scrubber operation. For greatest accuracy, buffer solutions should be selected that are close to expected pH values. Since the pH monitoring system electrodes may become fouled over time by dirt, particulates, and bacteria, calibration checks usually are necessary every few weeks.

CHAPTER III

REGULATIONS AND PERMITTING

INDEX

CHAPTER III

REGULATIONS AND PERMITTING

LEARNING OBJECTIVES

- Provide an overview of hazardous waste incinerator regulations and the permitting process.

- List and describe the types of waste and operating parameters that may be selected (by the permit writer) as permit-limited conditions.

A. INTRODUCTION

The regulations and permitting activities discussed in this chapter are directed toward hazardous waste incinerators operating under RCRA. The term incinerator applies to those enclosed, controlled flame combustion devices that do not meet the regulatory definition of boilers, and are not listed as industrial furnaces. The incinerators addressed directly by this manual tend to be permitted units, operated primarily to destroy waste materials, using controlled flame combustion.

As of press time for this manual (early 1989), new regulations were being developed by EPA to expand the range of controls applicable to incinerators. This chapter incorporates some of the concepts expected to be proposed in 1989; some of these concepts have already been incorporated into newer permits to address RCRA's broad goals of protection of health and environment.

An important fact for inspectors to remember is that the incinerator permit establishes the enforceable limits. The incinerator regulations primarily serve as the blueprint for the contents of the permit. Consequently, incinerator inspectors will be using the individual incinerator permits as the basis for inspections. The primary group of incineration-specific regulations under RCRA is provided in 40 CFR Part 264 Subpart O (final status), Part 265 (interim status), and Part 270 (permitting). Interim status is described in Chapter VI.

The overview of incinerator regulations and permitting in this chapter is intended to provide useful background information to inspectors. The descriptions of typical permit-limited parameters at the end of this chapter can serve as a quick reference for understanding the intent of a specific permit limitation. Inspectors are encouraged to develop a detailed understanding of the existing regulations and any newly proposed regulations.

B. REGULATORY OVERVIEW

RCRA incinerator regulations establish performance standards; requirements for waste characterization, operations, monitoring, and inspection; and the mechanism for permitting.

B-1. Terminology

An inspector should know these basic regulatory terms:

- <u>Appendix VIII Constituent</u>--one of the compounds listed in Appendix VIII (40 CFR 261).

- <u>POHCs</u> (Principal Organic Hazardous Constituents)--designated organic compounds used to measure the organic destruction performance of an incinerator. POHCs may be either normally present in the waste or added to it for testing purposes.

- DRE (Destruction and Removal Efficiency)--An efficiency value calculated for POHCs by conducting a series of performance tests. The calculation is a comparison of the input feed rate and stack emission rate of a POHC, expressed as a percentage value.

- Trial Burn--a detailed test program conducted to measure performance and to characterize the operations of the incinerator.

Inspectors should also be familiar with the term PIC (Product of Incomplete Combustion). PIC is a nonregulatory term that includes any byproduct of combustion including such compounds as CO, unburned constituents from the feed material, and any other compounds formed as a result of the combustion process (e.g., an organic constituent not present in the waste feed material). Although not directly regulated at present under RCRA, permits may contain limits on CO and/or total hydrocarbons in order to minimize PIC emissions.

B-2. Performance Standards

The incinerator performance standards under RCRA (as of January 1989) are:

- Particulate emissions $\leq$ 180 mg/Nm^3 (0.08 grain/dscf) corrected to 7% O_2 (264.343(c)).

- HCl emissions < 1.8 kg/hr (4 lb/hr) or 1% of HCl in stack gas prior to control device, whichever is less stringent (264.343(b)).

- DRE > 99.99% for most wastes (264.343(a)(1)).

- DRE > 99.9999% for dioxin surrogate (264.343(a)(2)).

The particulate standard is similar to the standards established prior to RCRA under national and local air pollution control programs for new municipal solid waste incinerators, boilers, and other combustion units. In addition to limiting particulate emissions, the particulate standard provides an indirect limitation of metal emissions, since many of the metallic species released by an incinerator are emitted as particulate.

The HCl standard limits the emission of the acid which is formed as a by-product of the incineration of chlorinated wastes. In addition, a risk-based HCl standard series is being developed (in 1989) to be used as a site-specific check to address concerns that the existing standard does not provide an adequate degree of protection in all cases.

The DRE standard is applied to the POHCs evaluated in the trial burn. The stricter standard of 99.9999% DRE is applied to POHCs that serve as dioxin surrogates in a trial burn for incinerators that will be permitted to incinerate wastes containing dioxins.

Expected Changes in regulations include:

- Limits on toxic metals (As, Be, Cd, Cr, Sb, Ba, Pb, Hg, Tl, Ag)
- Site-specific risk-based check on HCl to be used in conjunction with present performance standard
- 100 ppm limit on CO, otherwise continous monitoring of total hydrocarbons (THC). THC emissions should not exceed risk-based limits and a good operating practice level of 20 ppm.

The limits on metals and HCl under consideration are based on conservative risk-based screening limits. Limitations would be provided from a chart for either (1) input limits of HCl and the metals, (2) emission limits for each constituent, or (3) limits based on the results of site-specific modeling.

The CO limit would be based on a 60-minute rolling average (i.e., an average of the most recent 60- one minute readings corrected to dry basis and 7% oxygen). CO would be limited as an indicator of efficient combustion and, indirectly, as an indicator of minimal formation of toxic organic PICs. Monitoring of and limits on total hydrocarbons are being considered as a method to allow a variance from the 100 ppm CO limit.

EPA has determined that the permit writers must consider instituting the controls for PICs (and metals) using the omnibus provisions of Section 3005(c)(3) of RCRA.

Except for the CO limit and possibly the HCl limit, these performance standards cannot be monitored on a continuous basis. Therefore, permit limits are established for various waste characteristics, operations, and monitoring activities so that compliance with the performance standards can be reasonably assured on a continuous basis. It is important to note that, according to §264.343(d), compliance with the permit operating conditions is deemed to be compliance with the performance standards.

B-3. Waste Characterization Requirements

The RCRA Part B application must include a waste analysis plan. Waste materials fed to the incinerator must be characterized (264.341) in terms of chemical composition (e.g., the presence of Appendix VIII constituents) and any other waste characteristic that is critical to the performance of the incinerator such as chlorine content, heating value, viscosity, volatiles content, and solids content. (The exact parameters to be characterized and the minimum frequency of waste analysis are specified on a case-by-case basis in each facility's permit.)

B-4. Operating Limits

The operating limits for each incinerator are specified in the facility's permit. However, the following items are required specifically by RCRA regulations:

- During start-up or shut-down, hazardous wastes must not be fed to the incinerator unless operating conditions are met (264.345(c)).

- Fugitive emissions from the combustion zone (i.e., gaseous leaks) must be controlled (264.345(d)).

- Incinerators must be equipped with automatic waste feed cutoff systems that stop waste feed to the incinerator when conditions deviate from permitted limits for CO, waste feed rate, temperature, and combustion gas velocity indicator (264.345(e)). (Note: the permit writer may add other limiting parameters for this system in the permit.)

- Incinerators must not operate with hazardous wastes when any limits in the permit are exceeded (264.345).

B-5. Monitoring and Inspection

Although specific instructions for monitoring and inspection (by the operator) are listed in the permit, the following items are required specifically by RCRA regulations:

- Continuous monitoring of CO, combustion temperature, waste feed rate, and an appropriate indicator of combustion gas velocity (264.347(a)) (additional parameters may be specified in the permit).

- Daily inspections of incinerators for leaks, spills, etc. (264.347(b)).

- Weekly (or monthly) testing of automatic waste feed cutoff systems and associated alarms (264.347(c)).

- Monitoring and inspection data must be recorded in an operating log (264.347(d)).

B-6. Exemptions

The RCRA regulations (264.340(b)) provide an exemption from all 264 Subpart O requirements (except waste analysis and closure) for incinerators that receive hazardous wastes that are not toxic. These wastes:

- Are listed or classified as hazardous wastes solely because they possess the characteristics of ignitability, corrosivity, and/or reactivity.

- If reactive, do not generate toxic gases.

- Do not contain Appendix VIII constituents.

Incinerators which meet the first criterion and contain Appendix VIII constituents, but at levels which are insignificant, may be similarly exempted by the Regional Administrator under §264.340(c).

Incinerators qualifying for this exemption must be permitted under the requirements of Part 270.

C. PERMITTING OVERVIEW

The major steps of the permitting process for hazardous waste incinerators typically include (in chronological order):

- Submittal, review, and approval of the Part B permit application (including trial burn plan).

- Issuance of permit (for new facilities).

- Completion and approval of trial burn (test and results).

- Issuance of permit (for existing facilities) or modification of permit (based on results of trial burn for new facility).

The permitting of an incinerator is a very detailed and time-consuming process for both the applicant and the assigned permit writer. In addition to the typical facility requirements for a RCRA Part B application (e.g., facility descriptions, contingency, closure, training, etc.), an incinerator application must contain (according to 270.19):

- A detailed engineering description of the facility.

- Specific information about facility operations, monitoring procedures, and shut-down procedures.

- A sufficiently detailed trial burn plan that (1) addresses all sampling, analysis, and monitoring issues and (2) establishes the basis for future operations.

Before issuing a permit, the permit writer must become well-versed on all aspects of an incinerator facility, using the RCRA regulations, EPA guidance (see Appendix 4 for a list of applicable guidance manuals), available assistance from EPA sources or consultants, and best engineering judgment. The goal is a permit that is enforceable (e.g., specific, clear, and comprehensive). A permit is written to ensure that the performance standards will be met on a continuous basis (without unnecessarily constraining operations).

D. TYPICAL PERMIT-LIMITED PARAMETERS

The allowable operating conditions of an incinerator are defined in a permit in terms of reliably measured control parameters (e.g., temperatures, pressures, flows, etc.). These control parameters are especially important, since all of the RCRA performance standards (e.g., DRE and particulate emissions) cannot be measured directly on a continuous basis during normal operations.

This section serves as a glossary of common control parameters that are frequently included in a permit as a limiting condition to be monitored continuously. (A draft model of the incinerator-specific parts of a RCRA permit is presented in Appendix C.) The list of common parameters (summarized in Table III-1 and described in the following pages) is based on 1989 EPA guidance (EPA 1989a). Other parameters may be used in permits due to unique needs or new guidance issues. Additional information is provided in EPA, 1989a.

D-1. Minimum Temperature

Temperature often is considered to be the primary driving force in incineration. The minimum temperature is usually the lowest mean temperature that resulted in a successful trial burn test. Minimum temperatures are specified for both primary and secondary combustion chambers.

D-2. Maximum Waste Feed Rate

Limiting the waste feed rate to a rate proven during a trial burn tends to (1) prevent a reduction in incinerator performance due to overloading the combustion chamber, (2) keep residence time above the minimum level required to destroy organic constituents, (3) limit the heat released per unit volume, and (4) limit the ash and chlorine feed rates when used in conjunction with limits on the ash and chloride content in the waste feed in order to limit emissions of particulate and HCl.

D-3. Maximum CO

CO serves as an indicator of good combustion. By minimizing the emission of CO, operators tend to minimize the potential emission of organic products of incomplete combustion. Correcting the value to 7% oxygen

Table III-1. TYPICAL CONTROL PARAMETERS FOR HAZARDOUS WASTE INCINERATORS

Parameters Related to Waste Destruction

Minimum temperature at each combustion chamber exit

Maximum feed rate of each waste stream to each combustion chamber

Maximum CO emissions

Maximum flue gas flow rate or velocity

Maximum size of containerized waste to primary chamber

Parameters for Air Pollution Control Devices

Minimum pressure drop for venturi scrubber

Minimum water flow rate (or liquid-to-gas ratio) and pH to absorber

Minimum/maximum nozzle pressure to scrubber

Minimum water/alkaline reagent flow to dry scrubber

Minimum particulate scrubber blowdown rate

Minimum KVA for Electrostatic Precipitator and KV for ionizing wet scrubber (IWS)

Minimum liquid flow rate to IWS

Minimum and maximum pressure drop for baghouse

Maximum inlet gas temperature to air pollution control device

Maximum chloride and ash input in waste feed

Additional Parameters Based on Test Results or Design Limitations

Maximum pressure in primary and secondary combustion chambers

Maximum total heat input for each chamber

Liquid injection burner settings

- viscosity (maximum)
- turndown (maximum)
- atomization pressure (minimum)
- waste heating value (minimum)
- solids (suspended solids, particle size) (maximum)

Incinerability limits for organics

Adapted from EPA 1989a.

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normalizes the data to a common base, recognizing the variation in different combustion technologies and modes of operation.

D-4. Maximum Flue Gas Flow Rate/Velocity

Maximum limits for the selected indicator of gas velocity (e.g., flue gas flow rate, etc.) tends to control (1) gas residence time in each chamber, (2) gas throughput to minimize back pressure at joints and seals, and (3) gas flow rate through air pollution control devices to assure that they are not overloaded.

D-5. Maximum Size of Containerized Wastes

The size of containers is limited to minimize the effects of "puffing" (a sudden release of heat and gas from a bursting drum). Releases from oversized containers may temporarily overwhelm an incinerator's gas handling system. The loading rate of volatile organic material may also be limited to minimize puffing.

D-6. Operating Parameters for Air Pollution Control Devices

Most of the parameters listed on Table III-1 for air pollution control devices were described in Chapter II of this manual. The parameters in the table reflect basic monitoring needs for each of the devices; the needs at a specific facility for demonstrating adequate performance in controlling particulate and HCl emissions may justify permit limits and continuous monitoring of additional key control parameters.

D-7. Waste Limitations for Air Pollution Control Devices

The input rates of ash and chlorides (or halides) to an incinerator are normally limited in the permit to a level that is justified by the trial burn results. These levels limit the potential for violating particulate and HCl emission standards.

D-8. Maximum Combustion Chamber Pressure

The draft or pressure in the chambers of an incinerator is limited in order to minimize the release of partially burned organics or other products of combustion as fugitive emissions from the primary combustion chamber. Limits may be expressed for (1) incinerators designed to operate under positive pressure or (2) for negative pressure incinerators (which rely on draft to control fugitive emissions).

D-9. Maximum Total Heat Input

The total heat input to an incinerator may be limited in a permit to prevent operation outside of manufacturer design specifications.

D-10. Burner Settings for Liquid Injection

The burner operational settings for liquid injection should be within the manufacturers design and operating specifications. The settings relate to proper atomization of liquid waste and efficient mixing. Operating above a maximum viscosity (of pumped waste), below a minimum atomization fluid pressure, or above a maximum turndown (burner turndown is a ratio of design burner flow rate to actual burner flow rate) may not allow proper atomization and mixing. A minimum waste heating value may be specified when a given waste provides 100% of the heat input to a given combustion chamber. Maximum suspended solids and maximum particle size may also be limited within the manufacturers design specifications.

D-11. Incinerability Limits for Organics

Limits are placed in the permit concerning the organic constituents that can be fed to an incinerator. Limits are based on incinerability hierarchies, as described on page IV-22.

D-12. Other Potential Control Parameters

Some permits may list limits for minimum oxygen concentration, maximum kiln speed, or other parameters based on unique needs.

CHAPTER IV

INSPECTION OF INCINERATORS

INDEX

CHAPTER IV

INSPECTION OF INCINERATORS

LEARNING OBJECTIVES

- Describe the objectives of an on-site inspection of a hazardous waste incinerator.

- Identify the activities to be completed by the inspector before the inspection.

- Establish priorities via a checklist of the activities to be completed on site during the inspection.

- Describe appropriate documentation of inspection activities.

A. INTRODUCTION

The only direct method of verifying the adequacy of the performance of a hazardous waste incinerator is by conducting complex sampling and analysis tests. However, the cost of such tests is typically quite high ($30,000 to $100,000 or more), which makes frequent scheduled or unscheduled compliance testing problematic. Such tests involve simultaneous sampling of waste feeds and stack emissions and several types of analyses of the collected samples (a repeat of the "trial burn" testing required to obtain a permit). Consequently, even if frequent testing were feasible costwise, the complexity of planning and conducting the tests and evaluating data from them makes short-term determination of "real performance" impossible.

As a workable alternative, an indirect method of verifying adequate performance is used. The RCRA permitting program defines the adequate performance of a permitted incinerator in terms of specific monitored operating limitations that can be verified by an inspector. In developing the permit, the RCRA permit writer establishes an "operating window" of allowable operating conditions based on the results of trial burn tests. By definition, operation of the incinerator within the permitted operating window is equivalent to meeting the performance standards required by RCRA. The window is defined by an appropriate combination of parameters selected from a list such as the one shown in Table III-1.

The role of the inspector is to assess the performance of an incinerator by comparing <u>actual operations</u> with <u>permit conditions</u> (i.e., the set of limitations established in the permit). To make this comparison, inspectors will focus on the following types of activities:

- Noting observable operating standards and conditions
- Reviewing records
- Making calculation checks
- Conducting operational checks

Incinerator inspectors will use their limited time on site to log readings of key operating parameters from screens, meters, and charts; review waste characterization records; test automatic waste feed cutoff systems; observe calibrations of key monitoring equipment; visually assess operations, performance, and safety; and review operating records. Advance preparation is essential because each incinerator (and each incinerator permit) is unique.

<u>Priorities</u> for the inspection are established by the definitions of "in-depth" and "walk-through" inspections and the checklists that identify the objectives of these inspections.

The <u>in-depth</u> incinerator inspection typically involves <u>1 to 5 person-days</u> of effort (possibly a combination of on-site data gathering/investigation and follow-up data analysis in the Agency office). This inspection may be a stand-alone event or part of a more extensive, facility-wide inspection. An in-depth inspection may include a significant effort in evaluating records of past operations and auditing key instrumentation.

As a shorter alternative to the in-depth inspection, the walk-through incinerator inspection involves only 4 to 8 person-hours of inspection time on site. The actual time needed depends on the type (commercial or on-site industrial) and number of incinerators at the facility. The walk-through incineration inspection can be a stand-alone event or part of a more extensive facility-wide inspection.

The activities of these two types of inspections are outlined in a set of checklists (Appendix A) and are discussed in this chapter.

The remaining sections of this chapter address the efforts involved in planning, completing, and documenting incinerator inspections.

B. PREPARING FOR INCINERATOR INSPECTION

B-1. Preliminary Essential Steps

The key step in preparing for the inspection is to understand the limitations established in the incinerator permit. Since compliance with the operating conditions specified in the permit is regarded as compliance with RCRA performance standards, the permit itself establishes the criteria for the inspection.

Before going on site, the inspector must review and understand the permit. Feel free to contact the permit writer or other appropriate Agency staff to discuss any permit conditions that are unclear. In addition, if time is available, a review of the permit application will provide additional background on the layout, design, and planned operating objectives of the incineration facility. A review of past inspection reports (if applicable) is necessary to provide additional background information.

Check the enforcement files to identify any current or past problems. If available, waste manifest records will provide an additional preview of the facility's operations.

Prior to inspection, a checklist should be prepared. The checklist provided in Appendix 1 provides a template; the requirements of a particular facility's permit are added to the template checklist to produce a site-specific checklist that identifies all of the permit limitations to be verified during an inspection. (Development of the checklist is discussed in more detail later in this chapter.)

Ideally, the site-specific checklist will be prepared initially so that it can be used in any subsequent inspection. The checklist can be prepared by the permit writer (at the time of permit issuance) or by inspection staff (prior to the first inspection trip). Subsequent use of the checklist will require only a check of any permit modifications implemented since the most recent use of the checklist. Such a system minimizes the time needed in preparing checklists for future inspections but guarantees the completeness and accuracy of the checklist. State and EPA personnel should develop a procedure for preparing checklists for incinerators located in their region or state.

B-2. Making Arrangements

Arrangements to be made prior to the on-site inspection include a travel itinerary, directions to the site, and related practical and procedural activities as described in the RCRA Inspection Manual. However, additional special needs for an incinerator inspection may include discussing planned activities in advance with facility staff, making any necessary laboratory arrangements, and in some cases, obtaining data in advance.

If the inspection is not a surprise inspection, advance discussion with facility representatives concerning certain elements of the inspection will allow a more efficient use of the inspector's time on site. Consider the following three examples:

a. <u>The testing of the automatic waste feed cutoff systems</u> by the inspector can seriously interrupt operations at some facilities; advance scheduling of this activity will allow operating staff to plan accordingly and reduce untimely delays during the inspection.

b. <u>Contacting the facility to determine when the incinerator will be operating</u> can minimize the possibility that the unit will be down for scheduled maintenance or that a facility with limited incineration needs will not have wastes needing treatment.

c. <u>Instrument calibrations</u> are typically performed by specialty staff who may be available only at certain times; advance scheduling can guarantee the availability of appropriate staff.

d. <u>Data gathering</u> will typically require conversations with managers and laboratory staff who maintain records needed for review during the inspection. Again, advance discussions with the facility contact person will guarantee the availability of the appropriate staff and the needed information.

However, some trade-offs are involved with preliminary notice. Although appropriate staff and records will be available, equipment may be operating in an artificial mode with premium wastes. Problem equipment may be shut down for the scheduled inspection. Whereas, a surprise inspection may give the inspector a first-hand view of normal or representative operations. Records not immediately available could be mailed to the inspector. The inspector could take advantage of shutdown equipment by inspecting the refractory or other areas which are inaccessible during operation. State and regional personnel should determine what mix of surprise and planned inspections is necessary to evaluate compliance with permit conditions.

If the scope of the inspections includes sample analysis, the inspector should make advance arrangements with the Agency or contract laboratory.

As an optional activity, an inspector may ask for the advance submittal of selected records (e.g., waste feed characterization, operation logs, etc.) allowing the inspector to review selected information before visiting the site. This tactic may be useful if the inspector's available time on site will be very limited or if a public complaint is being investigated.

B-3. Obtaining Materials

An inspector may need to bring certain materials/supplies to the site, such as safety equipment, audit materials (e.g., standard gas), and if appropriate, check samples to be analyzed by the plant or containers for bringing split samples back to the Agency or contract lab. Any special needs for safety equipment should be discussed in advance with the facility contact.

B-4. Safety

Although this manual does not address the safety issues involved with inspections, inspectors should note that the traditional safety precautions applied by EPA staff at hazardous waste sites definitely apply to hazardous waste incinerators. Apply the procedures and policies presented in the safety training classes that are required for RCRA inspectors. In addition, be alert to possible hot surfaces, hot ash and residual liquors, liquids under pressure, and corrosive liquids. Maintain a strict hands-off policy (e.g., do not attempt to adjust valves or controls yourself; ask facility staff if adjustments are needed).

B-5. Summary

The importance of advanced preparation for an incinerator inspection cannot be overemphasized. Table IV-1 summarizes the specific needs for preparation.

C. THE IN-DEPTH INSPECTION

As implied by the name, an in-depth inspection is a very thorough evaluation of an incinerator, incorporating such key activities as:

- Detailed evaluation of operating conditions.
- Observation of activities.
- Audit of instrumentation.
- Review and spot check of records.

All of these activities have a direct purpose. The inspector's detailed evaluation of operating conditions provides a direct comparison of actual operations with permit limitations. The observation of activities includes a check of general facility conditions and the effectiveness of the RCRA-required inspections that are conducted daily by the operator. An audit of instrumentation checks the adequacy of key monitoring instruments. A review of records provides both a check of compliance with record-keeping requirements and a spot-check of past operations.

An in-depth inspection will require 1 to 5 person-days of on-site inspection depending on the complexity of the facility's operations and the needs of the Agency. A team of inspectors could perform an in-depth inspection in 1 to 2 days. The time needed to inspect a commercial incinerator that handles a variety of waste streams is significantly longer than the time needed for an on-site industrial incinerator that incinerates a limited number of waste streams.

Table IV-1. PREPARATION FOR INCINERATOR INSPECTIONS

Preliminary:

1. Review and Understand Permit
2. Review Incinerator Descriptions in the Permit Application
3. Review Past Inspection Reports, if any
4. Prepare Checklist ("walk-through" or "in-depth") (fill in permit conditions and essential information)
5. Review Enforcement File
6. Check Waste Manifest Records

Make Arrangements (as applicable):

1. Travel Arrangements and Directions to Site
2. Discuss Needs With Plant Including:
    a. Scheduling of Cutoff System Tests (impacts plant operations)
    b. Scheduling of Instrument Calibrations (availability of appropriate staff)
    c. Scheduling of Meetings With Managers and Laboratory Staff
3. Arrangements for Sample Collection and Laboratory Analysis
4. Ask for Advance Data (optional)

Obtain:

1. Safety Equipment
2. Audit Materials (standard gas, etc.)
3. Check Samples or Containers for Sample Splits

The following pages describe the activities to be completed during an in-depth inspection. The checklist package for an in-depth inspection is contained in Appendix A and outlines the activities and priorities to be incorporated into each in-depth incinerator inspection. Example pages of the in-depth checklist are presented on the following pages accompanied by a description of the activities.

C-1. Listing Basic Information

Before visiting the site, the inspector will document basic information concerning the facility, the incinerator(s), the permit, and past records on a checklist sheet as shown in Table IV-2.

Another useful piece of background information is a simple process flow diagram of the types and arrangement of major equipment in the incinerator. An example is shown in Figure IV-1. The diagram may be available in the permit application or may need to be developed by the inspector, either in advance from information in the permit application or during the inspection based on field observations. Such a diagram is often useful in planning, implementing, and documenting the inspection and subsequent inspections. The diagram should be attached to the checklist package.

C-2. Comparing Permit and Operating Conditions

A major part of each incinerator inspection is a comparison of actual operating conditions with the limitations established in the permit. The inspector will (1) evaluate actual operations at the time of the visit by reading the various gauges, charts, and screens used to monitor key parameters and (2) review recent and past operations by reading logs, strip charts, and any other recorded information concerning key operating parameters.

Table IV-2. EXAMPLE CHECKLIST PAGE: ESSENTIAL INFORMATION

RCRA INCINERATOR INSPECTION
CHECKLIST NO. 1--PERMIT AND OPERATING CONDITIONS

I. ESSENTIAL INFORMATION

Facility ______________________ EPA ID No. ______________________

Address ______________________
____
____

Facility Staff Involved (and Position) ______________________
____
____
____
____
____

Primary Contact ______________________
Phone No. ______________________

Names of Inspectors (and Office) ______________________
____
____

Dates of Visit ______________________
Time of Arrival ______________________

Incinerator(s) Inspected ______________________
____
____
____

Permit Identification and Date of Issue ______________________
(Date of most recent modification ____________)

Operational Status of Incinerator(s) ______________________
____
____
____

Date of Last Inspection ____________
(by State ___)
(by EPA ___)

Pending Enforcement Action ______________________
____
____
____

Previous Violations ______________________
____
____
____

Checklists Attached: No. 1 ____ (number of sets ____)
No. 2 ____
No. 3 ____

(Attach additional pages if necessary)

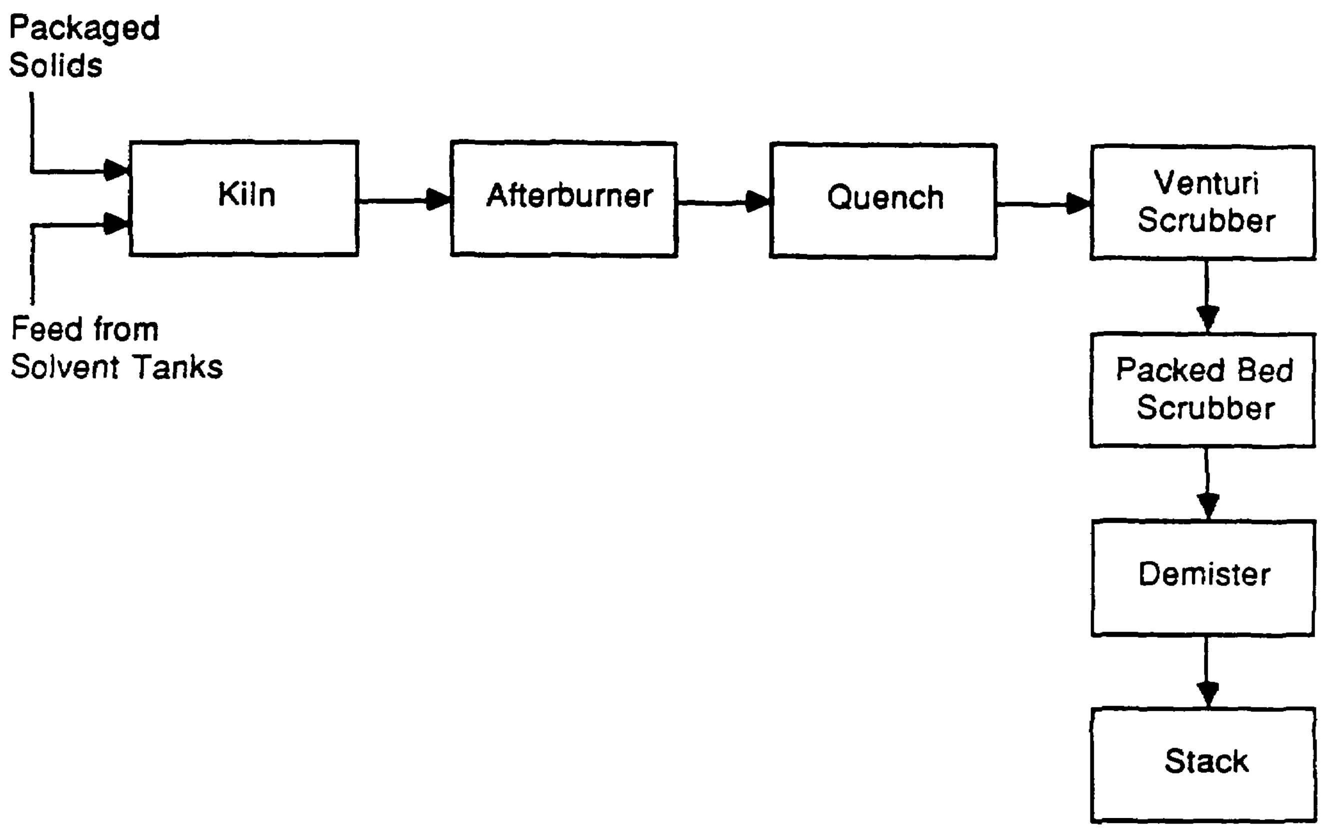

Figure IV-1. Example of a simplified process flow diagram.

C-3. Identifying Limiting Conditions

Since the permit itself establishes the criteria for the inspection, the inspector needs to identify in advance all of the appropriate limiting conditions to be verified during the inspection.

Unless a complete inspection checklist has been prepared previously (by the permit writer or for a previous inspection), the inspector will need to prepare a checklist based on the permit before conducting the inspection. This will involve filling in the blanks of the checklist (in Appendix A) for any limiting condition specified in the permit. For example, Table IV-3 is a checklist page indicating permitted limits for minimum primary chamber temperature, maximum CO concentration, and maximum flue gas flow rate. All checklist pages are to be completed accordingly.

Limiting parameters in an incinerator permit will vary with the specifics of each individual facility. The checklist package (in Appendix A) is designed to incorporate a wide variety of possible permit limitations, although all the possible limitations will not apply to any single facility. Extra spaces are provided for any additional permit-limited parameters. The inspector incorporates into the checklist only the parameters with limitations stated in the permit.

Having prepared the checklist in advance, the inspector is prepared to visit the incinerator site to gather information on present, recent, and past operations.

C-4. Logging Key Operating Parameters

After arriving on site and holding introductory discussions with facility contacts, the inspector should visit the incinerator control area for an initial logging of key operating parameters (i.e., the operating parameters limited as permit conditions). The observed values (and units) are recorded on the checklist.

Table IV-3. EXAMPLE CHECKLIST PAGE: PERMIT OPERATING PARAMETERS (WITH PRELIMINARY INFORMATION INCLUDED)

ID # EXAMPLE
Date ______

II. COMPARISON OF PERMIT AND OPERATING CONDITIONS

Date ______
Time Readings Began ______
Time Readings Ended ______

A. Permit Operating Parameters	Permitted Maximum (units)	Permitted Minimum (units)	Observed Reading(s) (units)	Calculated Value
1. Temperature measured at each combustion chamber exit				
a. Primary	NA	1600°F	______	NA
b. Secondary	NA	—	______	NA
c.	NA	______	______	NA
d.	NA	______	______	NA
2. CO emissions measured at the stack or other appropriate location (location: STACK)	100 ppm MAX (60 MIN ROLLING AVG)		______	______

• Does CO monitor automatically correct all readings to 7% O_2 based on actual O_2 stack concentration? ______ yes ______ no

If no, does permit require O_2 correction? ______ Does permit specify the correction factor to be used? ______ If so, list it. ______ Date correction factor last determined ______ Describe any changes made in O_2 correction factor. ______

Permit-specified frequency for verifying O_2 correction factor ______

• If a 60-minute rolling average is required, does the observed reading reflect a 60-minute rolling average?
______ yes ______ no ______ not applicable
If no, attach data and calculate the average. ______

3. O_2 emissions (location): ______ (______)	______	______	______	______
4. Flue gas flow rate or velocity measured at stack or equivalent method: (DRAFT AT EXIT OF CHAMBER)	-0.30 INCHES W.C.	NA	______	______

The key operating parameters typically are:

- Measured by instruments
- Monitored by gauges, screens, etc.
- Recorded in logs (manual and/or automatic)
- Recorded continuously by strip charts

The permit writer selected the appropriate parameters to monitor based on the specifics of the facility, the results of the trial burn test, EPA guidance, and best engineering judgment. The permit writer's review and approval of monitoring instrumentation included consideration of requirements for:

- Technique/type
- Specifications
- Location
- Data recording
- Calibration

As a follow-up to the requirements established by the permit writer, the inspector's activities include:

- Logging the readings from gauges, charts, and screens.
- Reviewing logs and strip charts.
- Evaluating the accuracy/precision of some of the instruments.
- Noting the replacement or modifications of any instrument.

(The last two items will be discussed later in this chapter.)

Although some older or smaller incinerator models may be operated from control panels adjacent to the incinerator or from controls mounted on the incinerator, most hazardous waste incinerators are operated and monitored in a remote control room. Computerized control rooms, which are gaining popularity, provide computerized set points for operation; automatically record operating logs; and display a variety of operating readings, trends, and data compilations on monitoring screens for the operators. Less sophisticated incinerator control rooms provide information to the operator on gauges, digital or analog readouts, meters, and charts, and rely on manually operated switches for control of the process. At most incinerators, inspectors can read values for permit-limited parameters at two locations in the control room--from a readout (digital or gauge) and from a data recording system (strip chart or computer system).

Regardless of the type of monitoring station, the inspector must exercise certain precautions in documenting the observed values of key operating parameters on the checklist. Major precautions include the following:

- Verify with the facility operator the <u>exact identification</u> of the parameter and location of the sensor (e.g., combustion gas temperature at the exit of the primary combustion chamber) before listing a value on your checklist. A parameter may have a similar name as the permit-limited parameter or may be measured in multiple locations; the permit should provide exact identification of the parameter and sensor location.

- Verify with the facility operator the <u>units</u> of each parameter. Be sure to note <u>correction factors</u> if applicable. Often a correction factor or multiplier factor may be taped to a meter or control panel, e.g., "Reading x 0.357 = CFM." Strip charts may log values as a percentage of full scale.

- Note that plant operators may view <u>different parameters</u> as "key" parameters for their purposes (e.g., fuel usage, excess air, draft). These parameters may be different from the parameters limited in the permit. It is possible that an operator may not be familiar with a specific parameter that is limited by the permit.

- For <u>computerized logs and readouts</u>, note the <u>format</u> of any readings (e.g., <u>instantaneous readings vs. time-averaged readings</u>). Most permit limitations are based on instantaneous readings with specification of any allowable time lags. However, certain permit limits (e.g., CO) may incorporate a rolling average (e.g., an average of the previous sixty 1-minute readings).

- Readings from integrators require multiple readings to determine a change over time (e.g., the change in total weight of an integrating waste feed scale over the period of 1 hour). The display from an integrator is typically a mechanical counter showing a four- to six-digit number.

- Readings from strip charts require special precautions. The following aspects of the strip charts are important in interpreting the readings and trends:

  - Note scale, orientation, units, possible multiple factors, and zero offset

  - Note the color of ink (a limiting factor in making copies of strip charts)

  - Identify the individual elements of multiple recorders

  - Verify time scale and labeling of dates

An example strip chart is shown in Figure IV-2. This chart displays three different parameters (CO, oxygen, and a reserved channel marked "spare"). This particular recorder automatically marks the date, time, and parameter (by number) on the chart. Unfortunately, strip charts at all facilities are not so sophisticated. Often the operator must manually identify dates, daily time lines, and the type of parameter labeled. The example demonstrates a common problem with multichannel strip charts--overlap of peaks from different parameters.

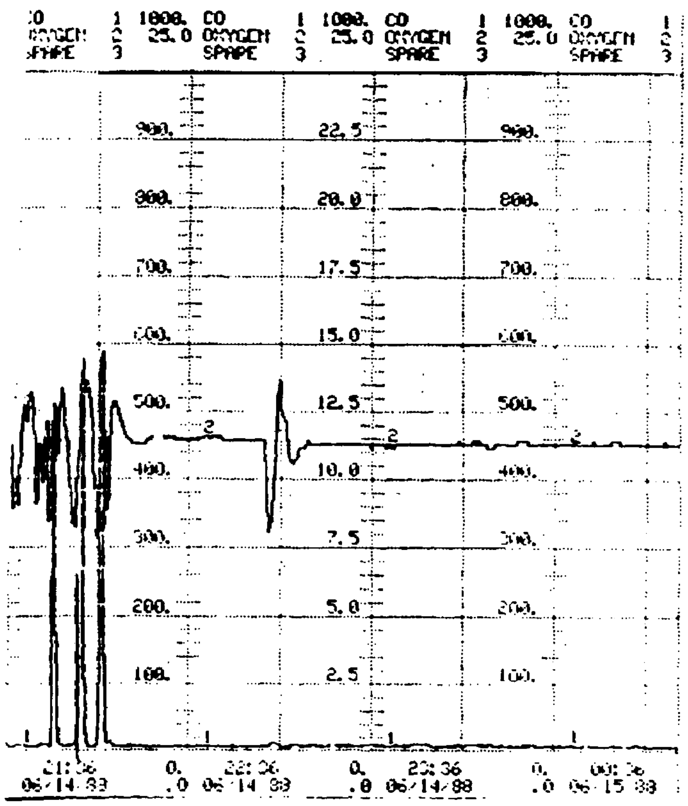

Figure IV-2. Example of a labeled, multichannel strip chart.

Even in highly computerized facilities, strip charts are often used to record the trends in operating conditions over time. The usefulness of strip charts to the inspector is a function of the diligence of the facility operators in maintaining the ink flow, paper orientation, chart speed, and adequate chart labeling. Problems with any of these basic record-keeping needs should be noted in the inspection report.

C-5. Collecting Monitored Data on the Checklist

The inspector observes readings for all of the permit-limited operating parameters and enters the values (and units) in the appropriate blanks of the checklist. An example of a completed checklist page is shown in Table IV-4. Some of the observed readings will require a further calculation step before the value can be compared directly to the permit condition. Any calculations should be attached to the checklist package. Inspectors should become familiar with the types of calculations that may be necessary, such as the example calculations provided in Appendix B.

For most of the limited parameters, completion of Part II-A of Checklist No. 1 (provided in Appendix A) is fairly straightforward. (The typical parameters were described in Chapter III.) However, notes are provided below for selected parameters:

- CO permit limits vary in format in response to changes in guidance as the RCRA permitting program develops.

    - Older permits may be two tier: "Cutoff after Y minutes at > X parts per million and immediately at > XXX parts per million."

    - Newer permits may be one tier: "A 60-minute maximum rolling average of 100 parts per million corrected to 7% oxygen." The O_2 correction factor may be based upon continuous monitoring of O_2 or upon a factor that must be revised at a specified time interval.

Table IV-4. EXAMPLE CHECKLIST PAGE: PERMIT OPERATING PARAMETERS (WITH INSPECTOR'S OBSERVATIONS INCLUDED)

ID # EXAMPLE
Date 1-5-89

II. COMPARISON OF PERMIT AND OPERATING CONDITIONS

Date 1-5-89
Time Readings Began 1100
Time Readings Ended 1130

A. Permit Operating Parameters	Permitted Maximum (units)	Permitted Minimum (units)	Observed Reading(s) (units)	Calculated Value
1. Temperature measured at each combustion chamber exit				
a. Primary	NA	1600°F	1789°F	NA
b. Secondary	NA	—		NA
c.	NA			NA
d.	NA			NA
2. CO emissions measured at the stack or other appropriate location (location: STACK)	100 ppm MAX. (60 min Rolling AVG)		10 ppm (SPONTAN)	15 ppm AVG (60 min)

• Does CO monitor automatically correct all readings to 7% O_2 based on actual O_2 stack concentration? ✓ yes ____ no

If no, does permit require O_2 correction? — Does permit specify the correction factor to be used? — If so, list it. ____ Date correction factor last determined — Describe any changes made in O_2 correction factor. —

Permit-specified frequency for verifying O_2 correction factor —

• If a 60-minute rolling average is required, does the observed reading reflect a 60-minute rolling average?
✓ yes ____ no ____ not applicable
If no, attach data and calculate the average. ____

	Permitted Maximum (units)	Permitted Minimum (units)	Observed Reading(s) (units)	Calculated Value
3. O_2 emissions (location): (____)				
4. Flue gas flow rate or velocity measured at stack or equivalent method: (DRAFT AT EXIT OF CHAMBER)	−0.30 INCHES WC	NA	−0.14 IN. W.C.	

- Flue gas flow rate/velocity may be measured by an alternative method specified in the permit. The checklist should list the method and contain the appropriate observed or calculated value.

- Liquid injection burner settings may be limited in terms of atomization pressure and feed rate or turndown ratio. If a turndown ratio is specified, the inspector must observe the flow rate to calculate the observed burner turndown.

C-6. Collecting Waste Characterization Information

Another critical set of limiting factors that are specified in the permit relate to the characteristics of the waste feed. Some limits may be established for the combined waste feed (i.e., a total limit); other limits may be specific to individual waste streams or individual waste feed locations (e.g., kiln solids feed, burner No. 3, etc.).

The inspector will compare permit limitations for the waste feeds with actual operations. However, this activity will not be as straightforward as the verification of process operating conditions for two reasons:

- Characterization of waste feed materials typically is not a continuous process. Wastes are reanalyzed typically on a minimum periodic basis as required in a waste analysis plan (i.e., at least once a year). The data collected by the inspector may be up to 1 year old.

- The results of the waste characterization may not be in a form that is directly usable. Reported results of analysis (e.g., a constituent concentration value) may need to be multiplied by an observed waste feed rate and any appropriate conversion factors (e.g., time, volume, specific gravity conversions) to produce a directly usable value. Total heat input values must also include the heat input of any auxiliary fuel used in the incinerator. Example calculations are provided in Appendix B.

Permit limits are established by the permit writer on a case-by-case basis for some or possibly all of the following:

- Ash and chloride (pounds/hour or %)
- Viscosity (maximum)
- Heating value (minimum/maximum)
- Metals
- Organic constituents

Although these permit limits are usually self-explanatory, some additional explanation may be appropriate for metals and organic constituent limitations:

- Limits on metals may be specified individually for noncarcinogenic metals [such as antimony (Sb), barium (Ba), lead (Pb), mercury (Hg), silver (Ag), and thallium (Tl)] and as a total limit for carcinogenic metals [arsenic (As), cadmium (Cd), chromium (Cr), and beryllium (Be)]. Details on any applicable limits will be specified in the permit.

- Limits on organic constituents may be based on a hierarchy of compounds rated in terms of incinerability (i.e., the degree of difficulty in incinerating the compounds). Two of the common ranking criteria are:

    - Heat of combustion index (e.g., allow the feeding of wastes containing only organic compounds with a heat of combustion exceeding a specified value). A list of hazardous organic compounds ranked according to heat of combustion is included in Appendix E. (The lowest values reflect the most difficult compounds to incinerate.)

    - Thermal stability index (e.g., allow the feeding of wastes containing only organic compounds with a higher incinerability ranking than a specified value or class). A list of hazardous organic compounds ranked according to thermal stability is included in Appendix F. (The lowest ranking numbers reflect the most difficult compounds to incinerate.)

The waste characterization data must be reviewed for waste constituents that exceed allowable limits (e.g., organic constituents that are more difficult to incinerate than the compounds or units specified in the permit).

Prior to the inspection, the inspector should complete the waste characterization section of the checklist (Checklist No. 1, Part II-B), incorporating all permit limitations associated with waste feed materials and fuels. An example checklist page is shown in Table IV-5.

During the inspection, the inspector will need to do the following, as appropriate to the specific situation:

- Collect the most recent analytical results for each of the waste streams fed to the incinerator during observed operation periods of the inspection visit.

- Enter the applicable analytical results on the checklist.

- Gather information on any conversion factors or supplemental data needed to make comparison calculations (e.g., specific gravity, fuel flow rate and heating value, etc.). All parameter values used in a single calculation should be from the same time frame.

- Complete any calculations needed to compare permit limits with actual operations. (Example calculations are provided in Appendix B.)

- Compare the permit limitations for allowable organic constituents with the results of analysis. Consult the appropriate incinerability index (Appendix E or F) if necessary.

Table IV-5. EXAMPLE CHECKLIST PAGE: WASTE CHARACTERIZATION (WITH PRELIMINARY INFORMATION INCLUDED)

ID # EXAMPLE
Date ________

CHECKLIST NO. 1 (continued)

8. *Characterization of wastes and fuels fed during the observation period*

1. Organics and physical characterization

		Organic constituents (limitations, compounds, etc.)	Ash (lb/hr)	Chloride (lb/hr)	Viscosity* (cP)	Heating Value (Btu/lb)	Specific Gravity ( )	Other
(a) Combined waste stream limitations in permit		NO CONSTIT. WITH HEAT OF COMBUST. ≤ CARBON TET.	630	1200	**100 cP	> 8000***		
(b) Limitations in permit for individual waste streams:								
Chamber	Waste Stream							
(1)								
(2)								
(3)								
(4)								
(5)								
(6)								

* FOR ATOMIZED WASTE FEEDS
** AT STORAGE TEMPERATURE
*** COMPOSITE FOR LIQUIDS AND FUEL

It is suggested that all calculations for this part of the inspection are completed on site during the inspection. Otherwise, it is possible that some piece of supplemental data (e.g., specific gravity) needed for a calculation may be forgotten. Data needs may differ significantly for each facility.

In reviewing analytical results, the inspector also should be looking for the possible detection of compounds that are specifically prohibited in the waste feeds by the permit (i.e., exclusive of an incinerability index). For example, some permits may specifically prohibit PCBs, dioxins, or other specific compounds from the waste feeds.

C-7. Variations in Approach to Data Gathering

The comparison of actual operating conditions with permit limitations is a key part of a RCRA incinerator inspection. The preceding two sections have described the activities (as summarized in Table IV-6) needed to check operations at the time of the inspector's visit. Depending on the time available for the inspection and the objectives of a particular visit, the inspector will also dedicate time to conducting a spot check of recent and past operation as part of an in-depth inspection. Three options are described below.

Option A Select Two or More Points in Time for an In-Depth Spot-Check of Operations

1. Obtain strip charts/review operator's logs for two different months (e.g., 1 month prior and perhaps 3 or 5 months prior).

2a. Look at the strip chart of a single key parameter (i.e., secondary combustion temperature, CO, or combustion gas velocity) and look for extreme or abnormal operations periods, or

Table IV-6. SUMMARY OF ACTIVITIES--COMPARISON OF PERMIT AND OPERATING CONDITIONS

Preliminary

Prepare the checklist by filling in permit conditions.

During the Inspection

- Collect observed readings for all operating conditions that are limited in the permit. Carefully note values and units on the checklist.

- Review the most recent waste characterization information for the wastes fed during the collection of readings. List values on the checklist, and complete any calculations needed to compare the waste characteristic with permit limitations.

2b. Look at the operator's log for upsets, the feeding of unusual waste materials, or other extreme or abnormal operating conditions, or

2c. Correlate data from records of upsets (e.g., for an excursion of low combustion chamber temperature look for a corresponding change in CO concentration).

3. Select one or more point(s) in time for each month to evaluate in more detail (i.e., an abnormal operating period if possible).

4. Complete Checklist No. 1 for each selected time. Collect readings for all permit-limited parameters from available strip charts, logs, and records. Obtain and review waste characterization data for the wastes that were fed to the incinerator at the selected times.

<u>Option B</u> Observe Operations During Different Time Periods of the Inspection Visit

1. Complete Checklist No. 1 for each selected time.

2. Try to select observation times that involve variations in operations if possible (e.g., different waste feed materials, different feed rates).

<u>Option C</u> Conduct a Spot Check of Operations Prior to Arriving on Site for the Inspection

1. Ask the plant to submit operating data for dates/times selected by you.

2. Review the data (on Checklist No. 1) prior to your inspection.

Priorities

- Option A should be completed for at least two points in time in every in-depth inspection.

- Option B should be completed whenever an in-depth inspection involves more than 1 to 2 days of on-site inspection time or for incinerators that operate under widely differing operating scenarios.

- Option C is probably most useful when the inspector's time on-site will be very limited or if a public complaint is being investigated.

C-8. Visual Assessment

The scope of an in-depth inspection also includes the more traditional elements of a facility inspection, such as looking for leaks, spills, potential malfunctions, and other issues potentially impacting environmental health and safety. Although some of the objectives of the visual assessment are direct response to RCRA regulations or permit conditions, many of the evaluations are subjective, related to potential performance problems and the general quality of the operation. For *example:*

- RCRA regulations (264.347) require daily inspection of the incinerator (and associated equipment) and that records of these inspections be kept by the facility. An inspector should obtain copies of the two most recent daily inspection reports prior to conducting the visual assessment. The inspector can compare his/her findings with the information contained in the operator's recent inspection records.

- RCRA (264.345(d)) requires the control of fugitive emissions from the incinerator combustion zone. During the visual assessment, the inspector will look for leaks from rotary kiln exit seals, air pollution control equipment, instrument sensor fittings, and emergency vent stacks in response to the regulatory requirements. The inspector will also look for corroding gas ducts and signs of poor maintenance that may indicate future problems with fugitive emissions.

Table IV-7 is an example page from the in-depth checklist that addresses visual assessment (Part I of Checklist No. 2 in the general checklist package). In this part of the inspection, the inspector is (1) looking for apparent malfunctions in the incineration facility, (2) searching for any procedural problems with the facility operations based upon records, operator function, and by-product/waste stream management practices, and (3) subjectively evaluating the general quality of the operation in conjunction with the broad objectives of RCRA.

The checklist serves as general guidance for the parts of an incinerator system that yield useful information in meeting the objectives of the inspection. Actual needs will vary with individual facilities and situations. The inspector is highly encouraged to go beyond the scope of the checklist, whenever appropriate, and to document findings via notes, photos, copies, etc., as needed.

The first element of the visual assessment is the observation of equipment/function. During a tour of the incineration facility, the inspector looks for such problems as:

- Leaks, fugitive emissions, problems with seals
- Structural integrity issues (corrosion, etc.)
- Improper function
- Safety issues

(There is a certain amount of overlap between these issues.)

Table IV-7. EXAMPLE CHECKLIST PAGE: VISUAL ASSESSMENT

ID # ____________
Date ____________

CHECKLIST NO. 2--VISUAL ASSESSMENT AND AUDIT ACTIVITIES FOR AN "IN-DEPTH" INSPECTION

I. VISUAL ASSESSMENT OF PERFORMANCE, OPERATIONS, AND ENVIRONMENTAL SAFETY

A. Observation of Equipment/Function [1, etc. = Problem note (see below)]

	Leaks/ Emissions	Seals	Structural Integrity	Proper Function	Safety Issues
--Waste unloading	____	____	____	____	____
--Waste storage/blending	____	____	____	____	____
--Waste handling/piping	____	____	____	____	____
--Waste feed/fuel systems	____	____	____	____	____
--Combustion chambers/burners	____	____	____	____	____
--Kiln drive system	____	____	____	____	____
--Combustion air fans	____	____	____	____	____
--Connecting ducts	____	____	____	____	____
--Pollution control devices					
•Absorber	____	____	____	____	____
•Venturi scrubber	____	____	____	____	____
•Ionizing wet scrubber	____	____	____	____	____
•Baghouse	____	____	____	____	____
•____________	____	____	____	____	____
--Emergency vent stack (dump stack)	____	____	____	____	____
--Process instrumentation	____	____	____	____	____
--Ash handling system	____	____	____	____	____
--Scrubber effluent handling	____	____	____	____	____
--____________	____	____	____	____	____

Notes

1.

The checklist (as in Table IV-7) identifies typical parts of an incinerator system that potentially develop problems affecting performance and environmental safety/health issues. Observe operations and ask the operators about any reoccurring problems and how these have been resolved. Through this part of the inspection, the inspector may note basic performance problems that are not apparent in the control room or may note future problems that can be avoided with proper response. (Information on some possible problems is presented in Chapter II of this manual.) Although waste-handling issues may overlap with the activities of a general facility inspection, the inspector should also include waste handling in any incinerator-specific inspection.

The second element of the visual assessment relates to observed operations including:

- General record keeping of all facets of the operations.

- The general adequacy of the facility operators and their knowledge of emergency/contingency procedures.

- The handling, fate, and nature of the waste streams produced by the incinerator (e.g., ashes, scrubber effluents, and stack emissions).

Basic record-keeping problems may be noted during the first inspection of a newly permitted facility. An inspector may need to suggest that more information be provided for use or review, ease of access, or an adequate level of detail to meet future inspection needs.

Trained and dedicated operating staff are an essential ingredient of a properly functioning hazardous waste incineration facility. A subjective evaluation of the operating staff by an inspector serves as a check upon the training requirements of RCRA. By posing questions to the operators about normal operational problems and emergency/contingency plans, the inspector may be able to judge the preparedness of the operators for such situations.

RCRA requires the proper management of any by-product of hazardous waste incineration. By-products "derived from" the incineration of listed hazardous wastes retain the listed waste code. For incineration of only characteristic wastes, any by-products should be classified as hazardous if they exhibit any hazardous waste characteristics. Although specific requirements may be provided in a facility's permit, in some cases a requirement may be deferred to the provisions of other regulations (e.g., scrubber effluent treated by an industrial wastewater treatment facility). As part of the in-depth inspection, the inspector should investigate the handling and fate of any incineration by-products/wastes and document the status of this activity.

In observing incinerator operations, an obvious activity of an inspector is to look at the appearance of stack emissions. Although RCRA regulations do not include an opacity standard, a general rule-of-thumb is that any visible emissions beyond a steam plume may tend to indicate a failure to meet the RCRA particulate emissions standard. The presence of visible emissions would tend to indicate a need for a more detailed inspection of air pollution control equipment. Local air regulations may also apply. (Steam plumes quickly dissipate to 0% opacity when cooled by ambient air; particulate-enriched plumes will disperse before losing opacity; more details on opacity measurement can be obtained from local, state, and EPA air program staff who are certified visible emissions observers.)

A third element of the visual assessment addressed in the checklist is a highly subjective evaluation of the general quality of operation including such issues as odors and "housekeeping." Problems in this category may serve as an indicator of problems in another segment of the inspection. For example, the presence of discarded equipment pieces (corroded pipes, scrubber packing, torn bags from a fabric filter) may indicate maintenance problems; discoloration of concrete pads or other surfaces may indicate past spills.

C-9. Auditing and Reviewing Documentation

This part of the inspection effort focuses on (1) the adequate function of selected monitoring and safety equipment and (2) additional documentation requirements that go beyond the review conducted in earlier phases of the inspection. The priorities for this phase are summarized in Part II of Checklist No. 2.

C-9-a. Audits of Equipment Function

Since certain permit-limited conditions are the primary indicators of adequate incinerator performance, it is vital that key monitoring equipment is functioning properly in an incineration facility. Also, the required automatic waste feed cutoff system is an essential safeguard when an incinerator's operations deviate from the allowable conditions. Both of these issues are investigated by the inspector in a series of functional audits. This part of the inspection can be time-consuming, especially if the inspector has not prepared in advance for these activities. Specifically, the inspector should list the permit limits for the automatic waste feed cutoff system on Checklist No. 2, and schedule the calibration and function checks in advance with the plant contact to avoid delays. The inspector should also have available for reference a list of any monitoring instrumentation calibration requirements stated in the permit.

The audits to be performed as part of an in-depth inspection include:

(1) Calibration Check of Continuous Emission Monitors

The inspector will observe a calibration check conducted by facility staff of each continuous emission monitor (CEM) required in the permit. (Note: All facilities must have a CO monitor; other requirements are facility-specific.) The results of the check are listed in Checklist No. 2.

Most of the CEMs installed at incinerator facilities are extractive CEMs. These have a fairly simple calibration procedure usually involving:

- A zero calibration--A reading of a calibration gas that does not contain the monitored constituent. For example, a nitrogen gas may serve as a zero calibration gas for an O_2 CEM.

- A span calibration--A reading of a calibration gas that contains the monitored constituent in a concentration that is about 80% to 100% of "full scale" of the instrument at the selected sensitivity scale, e.g., a span gas of 245 parts per million CO for a CO CEM operating in a 0- to 250-parts per million range.

Additional calibration at a midpoint between the "zero" and "span" points may be required in a permit to determine calibration error. The inspector can add another check step by bringing an additional standard gas on-site as an "unknown" calibration check. Results are documented on the checklist.

A special case involves "in situ" CEMs that may be used at some facilities. These units (described earlier in Chapter II) typically are not as simple to calibrate by direct methods (e.g., with standard gases) as extractive monitors. A check of the manufacturer's recommended procedure may be necessary. Calibration methods for in situ monitors may involve:

- Indirect calibrations (optical, electrical).

- Alternative calibrations (filling the stack with calibration gas).

- Comparisons with other CEMs.

The type of calibrations that can be checked during an inspection (and during normal operating periods) may be limited to the indirect calibration methods. The use of an "unknown" calibration check is probably not practical for an in situ monitor.

(2) Audit of the Automatic Waste Feed Cutoff System

The inspector will observe a test of the automatic waste feed cutoff system to determine if the system functions properly when required by the permit. Essentially, the inspector will test all of the sensors of the system individually and will test the actual cutoff mechanism once. The inspector's activities include:

- Listing <u>in advance</u> on the checklist the permit limits (a value and a time lag, if applicable) that trigger the automatic waste feed cutoff system.

- Observing the conditions that signal a cutoff.

- Observing adequate function of the cutoff mechanism (i.e., that the waste is actually cut off).

Testing of the automatic waste feed cutoff system can involve <u>simulated cutoffs</u> and <u>actual cutoffs</u>. <u>Simulated cutoff</u> may involve:

- Monitoring the cutoff signal received by a "dummy" receiver in response to a cutoff condition.

- Other indicators of cutoff activity that do not cause actual cutoff (i.e., action on a valve or switch "stuck" in the open position for the test).

Highly computerized systems usually have the capability of demonstrating the reception of a cutoff signal and overriding or misdirecting the actual cutoff signal so that an actual cutoff is not completed. More basic systems may require alternative methods to simulate cutoff or may only be able to conduct actual cutoffs.

For an in-depth inspection, the inspector should observe a test of the automatic waste feed cutoff system for all limiting parameters specified in the permit. To minimize the disruption of the incinerator operations, most of the testing can be based on simulated cutoffs. However, at least one cutoff test should include an actual cutoff of the waste feed system. (Note: On systems that are co-fired with a auxiliary fuel, it is not a burden to cutoff the waste feed. The auxiliary fuel keeps firing and the controllers maintain steady operation.)

Cutoff may be in response to:

- Actual cutoff conditions (e.g., low temperature)

- Simulated cutoff conditions (e.g., computer override, standard gas connected to CEM)

Cutoff testing may occur during normal plant operations or during special operating conditions (e.g., nonhazardous waste). Test conditions/schedule should be mutually agreeable to the inspector and the plant, although the needs of the inspection take precedence.

On the inspection checklist, the inspector records:

- Parameter value signaling cutoff
- Time lag
- Simulated or actual cutoff

Notes should be taken concerning any difficulties, impacts from waste feed cutoffs, or additional issues. Since a periodic check of the automatic cutoff system is required in the RCRA regulations (40 CFR 264.347(c)), the operator should have in place a standard procedure for routinely testing the system. Inspectors will also review the documentation of tests of the cutoff system and cutoff episodes (as discussed on page IV-41).

(3) Checks of Other Key Monitoring Instrumentation

Analogous to the calibration check of CEMs, the inspector is concerned that key monitoring equipment is functioning properly for all of the permit-limited operating parameters. Unfortunately, calibration procedures for many of the monitoring systems are not as simple and well-defined as the procedures for extractive CEMs.

Major elements of instrument calibration are precision and accuracy. Precision indicates agreement among a set of results without assumption of any prior information as to the true result. On the other hand, accuracy means the nearness of a result to the true result. For instrumentation, measurement of accuracy involves standards or reference materials. Multiple instrument comparisons can provide a related measurement. Examples are shown below:

Accuracy Check	Multiple Instrument Comparison
pH meter--measure pH of standard buffer solution	Thermocouple--compare reading with an alternate thermocouple
Feed scale--measure a standard weight placed on scale	Liquid feed rate indicator-- compare average reading over a time period with a measured volume change in the feed tank over the same time period

As a practical issue, accuracy checks may not be possible for some instruments. In situ installation may prohibit access of a reference material to a sensor for an accuracy calibration, or a suitable reference material may not be available. Typically, if the precision is known for real-time measurements and measurement taken during test episodes (e.g., the trial burn test) that indicated adequate performance of the treatment process, the inability to determine measurement accuracy is not a problem. For example, the accuracy of a 25- to 35-psi pressure gauge reading during a trial burn may not be as important as the precision of subsequent readings at that particular location, if that parameter is to be monitored as a permit condition.

Calibration requirements for a key monitoring instrument will consider the following:

- Manufacturer's specification/recommendations
- Procedure/frequency
- Practical considerations (accessibility, disruptive nature)
- Accuracy vs. precision

Ideally, the requirements for continuing calibration will be specified in the permit. Otherwise, the inspector's assessment of key monitoring instrumentation will be a case-by-case evaluation based largely upon procedures and frequency discussed with facility staff and noted in records.

As an example case, consider thermocouples which are commonly used for monitoring the critical temperatures in an incinerator facility. Typically, the word "calibration" when associated with thermocouples means one or more of the following:

- "Checked" at factory
- Compared with other thermocouples in situ (each combustion chamber)
- Possible in situ electrical check
- Replacement of nonfunctioning (or suspect malfunctioning) thermocouples

The most reasonable approach for an inspector would probably involve:

- A comparison of readings of redundant (i.e., duplicate) installed thermocouples.

- A review of temperature profile or trend across the system (i.e., highest temperatures in the combustion zone, lower temperatures through the quench/heat boiler or heat exchanger, lowest in the APC devices).

- A discussion with facility staff on the criteria used for replacing suspect malfunctioning thermocouples.

- A review of maintenance logs that document the installation of new thermocouples.

Ideally, any calibration requirements related to the other permit-limited parameters will be identified clearly in the permit (or will be referenced in the permit). An inspector's review of other instruments will vary significantly in approach and will depend on the specific requirements established for each instrument. (General information about some of these instruments is provided in Section II-D.) All observations should be documented; additional assistance should be obtained if concerns cannot be resolved adequately.

C-9-b. Additional Documentation Review

Documentation review, as approached in the earlier sections of the inspection, focused on such issues as:

- Operating conditions
- Characteristics of the waste
- Accessibility and completeness

Another group of objectives for the inspection includes a review of the adequacy of waste characterization and handling records and a review of other records required by permit (e.g., related to process upsets, inspections by the operators, and maintenance). These activities are listed in Checklist No. 2.

(1) Audits of Waste Characterization and Handling

The objectives of this review include evaluations of:

- Waste Characterization

  - Analysis of appropriate parameters
  - Frequency of analysis
  - Adequate analysis documentation (subjective)

- Waste Handling

  - Manifest/logs
  - "Fingerprint" analysis
  - Blending/feeding logs

Specifications and limits for these items may be provided in the permit.

Objectives for analysis documentation may be specified in a Quality Assurance (QA) Plan attached to the permit or incorporated in the permit application. To conduct a thorough review of the facility's analytical records in conjunction with the QA Plan, the inspector may need to obtain assistance from an analytical chemist/QA expert. Such a review may be appropriate for facilities that handle a wide variety of wastes or for particularly sensitive inspection situations. Otherwise, a subjective review by the inspector may be appropriate.

Facilities that receive wastes from off site typically conduct certain "fingerprint" analyses to verify the identity of the wastes received. Specific requirements for these analyses would be listed in the permit or in the waste analysis plan incorporated into the permit and should be verified by the inspector.

Facilities that feed a variety of waste materials to an incinerator may also have specific permit limits related to the blending of combined waste streams to meet operating objectives (e.g., to maintain a particular heating value, satisfy chloride-loading limits). The inspector should verify that any permit-required procedures are adequately documented.

(2) Review of Other Records Required by the Permit

Permits may include documentation requirements for the following:

Issue	Objectives of Inspection
Dump stack (i.e., emergency bypass stack) openings	Openings, causes, and corrective action documented Temperature maintained during openings Minimum airflow maintained during openings
Automatic waste feed cutoff	Documentation of cutoffs and testing of system Note frequency of cutoff incidents
Inspection logs/calibration records	Complete Adequate schedule Note any recurring problems
Maintenance records	Complete Timely corrective action Routine maintenance performed on schedule Recurring problems Replaced equipment

In conjunction with the permit and Checklist No. 2, the inspector should take notes on the status and adequacy of any of the above issues that are required in the permit.

The collection of information about replaced equipment is an important objective of the inspection. Inspectors need to provide the permit writer information to evaluate the specifications of replaced equipment (e.g., monitors) and to determine whether the replacement was allowable without a permit modification. The replaced equipment can potentially affect the operating conditions of the incinerator.

C-9-c. Audit of Analytical Procedures (Optional)

A control agency may decide to conduct an audit of waste analysis conducted by the incineration facility. Options for this audit may involve the following:

- Inspector provides check samples for analysis in facility lab, or
- Inspector obtains sample splits for analysis in agency lab.

The responsibilities of an inspector for such an audit include:

- Documenting the origin of samples
- Transmitting details to labs
    - Parameters and methods
    - Handling/storage limitations
    - QA/QC requirements

More details for laboratory inspections can be found in the RCRA Laboratory Audit Inspection Guide Document (EPA, 1988c).

C-10. Summary of an In-Depth Inspection

The general effort for an in-depth incinerator inspection is summarized in Table IV-8.

D. THE WALK-THROUGH INSPECTION

The walk-through inspection is an evaluation of a hazardous waste incinerator that incorporates activities such as:

Table IV-8. SUMMARY DESCRIPTION OF AN IN-DEPTH INCINERATOR INSPECTION

- Prepare a checklist in advance based on the permit.
- Record actual observed values for all permit-limited operating parameters.
- Record the most up-to-date waste characterization data for the wastes fed to the incinerator during observation period(s).
- Gather additional information on actual operating conditions and waste characteristics for past points in time or from additional observations.
- Conduct a visual assessment of the facility and its operations.
- Conduct an audit of equipment function for the automatic waste feed cutoff system and key monitoring equipment.
- Conduct a detailed review of all records required by the permit.

- Detailed evaluation of operating conditions at the time of the visit.
- General observation of activities.
- Quick audit of selected instrumentation.
- Limited review of records.

This incinerator-specific inspection may require only 4 to 8 person-hours of inspection time on site. The actual time needed depends on the type of incinerator and the number of incinerators at the facility. For example, a walk-through inspection of a commercial incinerator will probably require about 8 person-hours; an on-site industrial incinerator burning a limited variety of wastes may require about 4 person-hours, depending on the complexity of the facility and the permit. If additional incinerators are installed at the site, allow about four additional person-hours per incinerator for a walk-through inspection.

The walk-through inspection is designed to provide a detailed picture of observed operations at the facility within a minimal on-site time period. The priorities are established via checklists. In Appendix 1 (the checklist package), Checklists No. 1 and 3 are used in a walk-through inspection.

The following pages describe the activities to be completed during a walk-through inspection. Frequent references are made to descriptions of an in-depth inspection when there is significant overlap between the two types of inspection.

D-1. Listing Basic Information

The discussion of basic information on page IV-10 of this manual also applies to walk-through inspections.

D-2. Comparing Permit and Operating Conditions

The description on pages IV-10 through IV-28 also applies to walk-through inspections. The comparison of operating conditions with permit limits is probably the key observation of any incinerator inspection. In summary, the activities for this part of the inspection involve the following:

- Prepare the checklist (Checklist No. 1) in advance by filling in permit conditions.

- Collect observed readings for all operating conditions that are limited in the permit.

- Review the most recent waste characterization information for the wastes fed to the incinerator during the collection of readings. List the values on the checklist, and complete any calculations needed to compare the waste characteristics with permit limitations.

By definition, the walk-through inspection includes a review of only the actual operating conditions noted during the inspector's visit (i.e., a copy of Checklist No. 1 covering only one point in time). However, if additional time is available, the inspector could go a step beyond the walk-through format by reviewing operations documents for recent and past operations as described on page IV-25 (Option A).

Although such a review can be time-consuming, this activity could serve as a check of continuing compliance, thus increasing the value of a walk-through inspection.

Option C (see page IV-27), which is a spot-check of operations conducted prior to the inspection, is also a useful option for a walk-through inspection.

D-3. Visual Assessment

This part of the inspection (as outlined in Section I of Checklist No. 3) is similar to the activities described on pages IV-28 to IV-32 for an in-depth inspection. The major activities of this portion of a walk-through inspection include:

- The observation of equipment/function
- Assessment of observed operations
- Assessment of the quality of operation

Checklist No. 3 differs from the in-depth checklist in the priorities for assessment of observed operations. This part of the inspection (see Table IV- 9) looks at:

- The general completeness of records required in the permit
- A subjective evaluation of the facility operators
- The appearance of stack emissions

The review of documents tends to be a cursory review in the walk-through inspection. A more detailed level of review is not practical within the planned time frame of the walk-through inspection.

D-4. Quick Audit of Performance

The priorities established for the inspector to conduct a quick audit of performance in Section II of Checklist No. 3 are:

- A calibration check of each continuous emission monitor (CEM) required in the permit.

- Observation of the operation of the automatic waste feed cutoff system in response to at least one upset condition.

Table IV-9. EXAMPLE CHECKLIST PAGE: OBSERVED OPERATIONS (FOR A WALK-THROUGH INSPECTION)

ID # ____________
Date ____________

CHECKLIST NO. 3 (continued)

B. Observed Operations [Give brief description of problem or reference a note below (1, 2, etc.)]

Status/Comments

--Records of permit parameters ____________

--Proper identification of date, time, and units on strip charts ____________

--Records of automatic waste feed cutoff (AWFCO)

- Documented ____________
- Frequency of cutoff incidents _____ per month or _____ per day (average of _____ days)
- Major causes for AWFCO ____________

--Records of dump stack openings

- Openings documented: _____ incidents since ________ (date of last inspection) or ______ in last 12 months (reported to ____state or ____EPA)
- Temperature and airflow maintained ____________
- Causes ____________

--Records of waste acceptance ____________
handling ____________
characterization ____________

--Log of inspections ____________
calibrations ____________
maintenance ____________

--Staff knowledge of emergency procedures ____________
contingencies ____________

--Appearance of stack emissions ____________

--____________ ____________

--____________ ____________

Notes

1.

The CEM calibration check is conducted as described on page IV-33. The feed cutoff observation is a shortened version of the activities described on page IV-35. For both of these activities, the inspector's observations are noted in Checklist No. 3.

D-5. Summary of the Walk-Through Inspection

This inspection format essentially assembles the highest priority inspection activities of an in-depth incinerator inspection into two checklists (Checklists No. 1 and No. 3) to be completed in about 4 to 8 person-hours on site. If more time is available to the inspector, a spot-check review of recent and past operations (as described in Option A, page IV-25) is highly recommended.

E. THE INSPECTION REPORT

Both the RCRA Inspection Manual (EPA, 1988a) and the RCRA Technical Case Development Document (EPA, 1988b) provide detailed information on inspection reports. The RCRA Inspection Manual notes that "The adequacy of follow-up to correct problems or deficiencies noted during an inspection depends greatly on the report package the inspector prepares following the inspection."

The report should contain:

- Completed narrative (the factual record including descriptive detail of items relating to potential violations and discrepancies)

- Completed checklist pages and associated calculation sheets

- Supporting documentation which may include:

  - Log sheets/printouts
  - Copies of strip charts (with appropriate labeling)

- Laboratory results
- Facility inspection/calibration/maintenance records
- Specifications for any replaced equipment
- Selected pages of the permit and previous inspection reports
- Diagrams and photographs
- Correspondence
- Any other supporting documentation

Additional guidance on preparing inspection reports is provided in the RCRA Inspection Manual and the RCRA Technical Case Development Guidance Document.

CHAPTER V

IDENTIFYING AND DOCUMENTING POTENTIAL VIOLATIONS

INDEX

CHAPTER V

IDENTIFYING AND DOCUMENTING POTENTIAL VIOLATIONS

LEARNING OBJECTIVES

- Encourage inspectors to identify potential violations while in the field.

- Describe the additional activities and documentation of potential violations.

- Discuss potential violations involving numerical limits and other issues.

A. IDENTIFYING POTENTIAL VIOLATIONS

While conducting the inspection and comparing actual operations and records with permit conditions, inspectors will be looking for potential violations. In some cases identification of potential violations may be very simple. (For example, an observation that a secondary combustion temperature is operating 200°F below the allowable minimum temperature while burning hazardous waste; or a facility is unable to provide records of waste characterization data for a hazardous waste stream that was incinerated in a previous month.)

For other cases an inspector may be unable to identify a potential violation until a calculation can be completed, a discussion is held with the permit writer, analysis results are received from the agency lab, or other similar follow-up activities are completed. (For example, the permit writer decides that a newly replaced CO monitor is not technically adequate for meeting RCRA monitoring requirements, or analysis results from the agency lab indicate a 100-ppm concentration of PCB in an incinerated waste stream, although the permit specifies that wastes containing PCB cannot be fed to the incinerator.)

For either type of situation, it is essential that the inspector provide adequate documentation of the potential violation to satisfy the needs of any enforcement case development activities. The most critical documentation often occurs during the inspection, at the time and place where an inspector can collect physical evidence and obtain direct information from facility staff.

This chapter provides suggestions for inspectors on how to develop adequate documentation for potential violations that have been identified during the inspection. The following sections address documentation for potential violations of numerical limits and general documentation activities for other types of potential violations. The RCRA Inspection Manual (EPA, 1988a) and the RCRA Technical Case Development Guidance Document (EPA, 1988b) also provide detailed information on identification and documentation of potential violations.

B. POTENTIAL VIOLATIONS OF NUMERICAL LIMITS

As discussed previously in this manual, many of the critical permit limits for hazardous waste incinerators are listed in each permit as allowable minimum and maximum values for selected parameters. Inspectors list observed values or values recorded in facility records on site-specific checklists and are able to identify potential violations, either immediately or after completing any necessary calculations, by making a quick comparison.

Whenever potential violations are noted, inspectors should take additional steps to document the validity of the suspect value as follows:

1. Collect physical evidence of the suspect value.

    a. Take notes of the time, location, origin, and value of the reading/record. Note the length of the time period when the value appeared to be outside of the allowable range. Take readings from alternate sources if available (e.g., strip chart, computer log, duplicate, or stand-by instrument).

    b. Interview the operator to verify the value you have listed is correct (correct units, location, interpretation, etc.).

    c. Obtain copies of logs and strip charts that record the subject value.

    d. Take a picture of the value reading if possible (i.e., if the value is available on a readout or gauge).

2. Collect background information on operations at the time of the observed/recorded suspect value.

    a. Log on the checklist or in the inspection notes the values of any other parameters that may have contributed to or may have been affected by the suspect value (e.g., temperature, waste flow rate, CO, gas velocity).

    b. Take notes of the status of operations at the time the suspect value (as observed or as recorded). Items of interest may include the type of wastes fed to the unit, staffing (operators and supervisors on duty), shutdowns before/after the time of the suspect value, check for upsets and equipment malfunction, etc.

c. Document the condition of the instrument that provided the suspect reading. Obtain a copy of calibration and maintenance records for the instrument.

3. Discuss the suspect value with facility staff.

a. Identify your finding to the operator and ask for an explanation. Take detailed notes (quote if possible).

b. Repeat the conversation with the engineer or supervisor overseeing operations and take detailed notes (quotes).

4. Follow up within your agency (as discussed in Chapter VI of this manual).

Because the most critical documentation in support of a potential violation is obtained on site, inspectors are encouraged to identify potential violations during the inspection. For example, if time is available to complete on-site any calculations needed to evaluate a permit limit, potential violations of those particular limits can be identified during the inspection. Then additional documentation can be gathered by the inspector before leaving the site.

C. OTHER TYPES OF POTENTIAL VIOLATIONS

Aside from numerical issues, potential violations for a hazardous waste incinerator may involve such issues as:

- Insufficient records.

- Maintenance problems (including calibrations).

- Improper handling of residual wastes (ashes, scrubber effluents).

- Incomplete waste characterization.
- Inadequate inspections of equipment.
- Insufficient training/qualifications of staff.
- Visible emissions (that indicate potential performance problems).
- Inoperable waste feed cutoff systems.

When inspectors identify these types of potential violations, the following activities should be considered to provide adequate documentations:

1. Collect physical evidence of the suspected violation.
    a. Take detailed notes of observations.
    b. Obtain copies of any documents (logs, records, etc.) that support the problem or indicate a lack of required action.
    c. Take pictures if appropriate.
2. Discuss the suspected violation with facility staff.
    a. Identify your concern with operating staff and facility management. Take detailed notes (quote if possible).
    b. Ask facility staff if any "missing" information is available from other individuals at the facility or in another office.
3. Follow up within your agency (as discussed in Chapter VI of this manual).

For example, an inspector may note an apparent failure of a facility to keep records of the testing of the automatic waste feed cutoff as required in the permit. An inspector in this case may:

- Take notes of the effort made to obtain the records.

- Look at strip charts throughout a monthly period in conjunction with the operations log to identify any shutdown periods caused by either upset conditions or test conditions.

- Discuss the missing information with the on-duty operator and the facility operations engineer. Take notes of their responses.

- Ask the facility manager if the test information may be retained by a maintenance supervisor or another staff member.

- Follow up within the agency after the inspection.

As another example, an inspector may notice during a review of records that the facility has not conducted calibrations of a waste feed measurement instrument on a semiannual basis as required in the permit. An inspector in this case may:

- Take notes of the effort made to obtain records of completing the required activity (calibration).

- Discuss the missing information with the on-duty operator and the facility operations engineer.

- Follow up within the agency after the inspection.

This type of an approach would also be appropriate for potential violations involving incomplete waste characterization and inadequate inspections of equipment.

A different type of example may involve an inspector's observation that the opacity of observed emissions (beyond the steam plume) indicates a potential problem with adequate air pollution control. In such a case a RCRA inspector might proceed as follows:

- Take notes of general observations and concerns.

- Document the observed values of all monitored parameters associated with the air pollution control equipment.

- Discuss maintenance of air pollution control equipment with the responsible staff.

- Discuss observations with supervisor at the agency. Consider requesting immediate assistance from air programs staff possibly including a certified visible emissions observer and an air programs inspector who evaluates air pollution control equipment.

In this particular example the potential violation may involve an air permit or ordinance and potentially the RCRA permit, depending on applicable regulations and specific permit conditions. A similar approach could be used for a potential violation related to improper handling of residual wastes (ashes, scrubber, effluents). Such a situation may involve other agency program areas (e.g., water programs).

Lastly, the inspectors are encouraged not to characterize any findings as "violations" when debriefing facility staff unless absolutely certain. A finding of violation is usually made by an enforcement official after consideration of all facts and evidence regarding a potential violation. It would be, at the very least, an embarrassment for the Agency to have a facility spend money correcting a "violation" cited by an inspector, only to find that upon further consideration that a violation did not exist.

CHAPTER VI

FOLLOW-UP AND SPECIAL ISSUES

INDEX

CHAPTER VI

FOLLOW-UP AND SPECIAL ISSUES

LEARNING OBJECTIVES

- Identify potentially important follow-up activities to the inspection.

- Describe appropriate activities for four special inspection cases:

    - Interim status incinerator
    - New incinerators
    - Post-trial burn operations
    - "Exempt" incinerators

A. FOLLOW-UP TO THE INSPECTION

After completing the inspection, the inspector compiles information for the inspection report. Additional calculations may need to be completed back at the agency office, using information to be submitted by the facility, or the issuance of the report may be delayed a few weeks awaiting the results of analysis. After all of the final pieces are available, the inspector may still have some remaining questions or uncertainties that should be resolved before issuing the inspection report.

The RCRA Inspection Manual (EPA 1988a) identifies the general usefulness of follow-up discussions with the inspector's supervisors and the permit writer as well as procedural discussions concerning federal/state jurisdiction. Discussions with Agency attorneys on these issues are very important. Additional specific follow-up discussions may be appropriate after an incinerator inspection. Examples include:

- **Discussions With the Permit Writer**

    - General/specific questions about the incinerator design and operation; permit conditions, etc.

    - Specific details concerning any replaced equipment and whether the replacement requires permit modifications.

    - Potential violations identified by the inspector (e.g., Is this actually a violation? How serious is this issue?).

      (Ideally, the individual who wrote the incinerator permit has the most experience to share. If this individual is no longer with the Agency, another experienced incinerator permit writer may possess the skills to answer most questions.)

- **Discussions with Technical Experts**

    - Technical questions concerning air pollution control, chemical analysis, quality assurance, instrumentation, etc.

- **Discussions with Representatives of Other Agency Programs**

    - Concerns associated with gaseous emissions (air programs), improper handling of effluents (water programs), etc.

In addition to providing a factual, comprehensive inspection report to circulate to responsible agency staff and the inspection file, the inspector should <u>verbally</u> apprise selected agency staff of the nature of any findings that indicate a need for follow-up action. Reports and memos may tend to pile-up on desks and not receive immediate review or action. The inspector should report verbally to appropriate staff any findings judged to be of significant importance.

B. SPECIAL ISSUES

This manual has addressed primarily the inspection of permitted incinerators that are operating under permit conditions established from a successful trial burn. There may be times when an inspector is involved with facilities that do not fit into that general category. The following pages outline inspection approaches for four special cases:

- Interim status incinerators
- New incinerators (not yet tested)
- Post-trial burn operations
- "Exempt" incinerators

B-1. Inspection of Interim Status Incinerators

The requirements under RCRA for interim status incinerators (40 CFR 265, Subpart O) essentially are limited to the following:

- Analysis of wastes not previously burned
    - heating value
    - halogen content
    - sulfur content
    - concentrations of lead and mercury

- No hazardous waste feed during startup and shutdown
    - steady-state airflow
    - steady-state temperature

- Monitor emission/combustion control instruments every 15 minutes
    - waste feed
    - auxiliary fuel
    - airflow
    - temperature
    - scrubber flow and pH

Also, interim status incinerators may burn wastes containing dioxin only if certification is obtained for meeting the applicable Part 264 performance requirements.

The scope of an inspection for this kind of facility would probably be limited to the general issues addressed in Section I of Checklist No. 3 (see Appendix A). A primary issue would be the adequacy of process monitoring.

B-2. Inspection of a New Incinerator

An inspector may become involved in inspecting a new RCRA incinerator that has not yet completed a trial burn test. Major activities for such an inspection will be based on the limitations established in the facility's permit. Basic inspection activities for this situation include:

- Verify installation of monitoring equipment as specified in permit or permit application.

- Verify construction of the incinerator and support equipment in accordance with the specifications in the permit or permit application.

- Verify shakedown period requirements

    • No greater than 720 hours of operation with hazardous wastes (or within limits in the approved extension agreement)

    • Operating parameters within permit limits for shakedown period

- Verify adequate completion of compliance schedule (if any)

Appendix G provides a checklist for inspection of a new RCRA incinerators. The checklist suggests the priorities and level of documentation that are appropriate for this type of inspection.

B-3. Inspection of Post-Trial Burn Operations at an Incinerator

During the period of time immediately after the trial burn and until the results of the trial burn have been incorporated as permit limits or permit modifications, the incinerator is operating in a post-trial burn period. Limiting conditions for operation of the incinerator in this time period are established in:

- The operating permit for a new facility, or

- Part 265 standards for an interim status facility.

If an inspector's services are needed in this time period, the basis for the inspection will be the limitations established by the permit or Part 265 standards. Typically, the limitations for a new facility are similar to the operating conditions planned for the trial burn. However, the allowable wastes to be fed to the incinerator after the trial burn may be more restrictive. Inspectors may be able to use the walk-through inspection checklists (i.e., Checklist Nos. 1 and 3 in Appendix A) as a format for a post-trial burn inspection.

B-4. Inspection of "Exempt" Incinerators

Hazardous waste incinerators that are exempt from most of the requirements of 40 CFR 264, Subpart O (as described on p. III-8) are those permitted incinerators burning waste that are classified as "hazardous" solely based upon the regulatory definitions of corrosive, ignitable, and/or reactive wastes. If exempted under §264.340(b), an incinerator may not burn wastes with any Appendix VII constituents. If exempted under §264.340(c), the waste may contain only those Appendix VIII constituents allowed under the permit, and the concentrations of those constituents must be below the "insignificant" levels specified in the permit. Typically, the permit limitations of these incinerators are fairly minor except for requirements of waste characterizations.

An inspection of a permitted exempt incinerator involves:

- A thorough review of waste analysis results, including a review of the possible presence (and if applicable, concentration) of Appendix VIII constituents in the wastes.

- A comparison of any specific permit limitations with actual operations.

The inspection of permitted exempt incinerators may require the use of only very limited sections of the RCRA incinerator inspection forms package (e.g., waste characterization).

CHAPTER VII

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INCINERATORS--GUIDANCE

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(Additional guidance manuals are listed in Appendix D.)

APPENDIX A

RCRA INCINERATOR INSPECTION CHECKLIST PACKAGE

RCRA INCINERATOR INSPECTION FORMS

Developed by Midwest Research Institute
for the U.S. Environmental Protection Agency
January 1989

I. Background

The attached set of forms identify activities appropriate for compliance inspection of RCRA incinerators. The set of checklists includes:

- Checklist No. 1 - Permit and Operating Conditions
- Checklist No. 2 - Visual Assessment and Audit Activities for an "In-Depth" Inspection
- Checklist No. 3 - Visual Assessment and Audit Activities for a "Walk-Through" Inspection

The checklists are designed to be used for two types of inspection--a "walk-through" inspection requiring about 3 to 4 hours and an "in-depth" inspection requiring 1 to 5 days. The following checklists are suggested:

"Walk-through" Inspection	"In-depth" Inspection
Checklist No. 1	Checklist No. 1
Checklist No. 3	Checklist No. 2

II. Notes on Individual Checklists

- Checklist No. 1 is based on EPA guidance (January 1989 "Guidance on Setting Permit Conditions and Reporting Trial Burn Results"). Blanks are included for additional parameters. Multiple sets of Checklist No. 1 may be used to evaluate operations at various selected times during a multi-day "in-depth" inspection or to evaluate past operations at selected times using facility records. All calculations must be documented in extra calculation pages. Note in the checklist the page numbers of the documented calculations.

- Checklist No. 2 is for "in-depth" inspections only. Part I is highly subjective, relying on judgment. Part II includes activities that may require scheduling to avoid interferences with facility operations (e.g., testing of automatic waste feed cutoff) and arranged meetings with facility managers and laboratory staff.

- Checklist No. 3 includes visual assessment and audit items of highest priority from Checklist No. 2. This checklist is intended for "walk-through" inspections only. Activities may require scheduling to avoid interferences with facility operations.

III. General Instructions

- Fill in permit conditions in advance; label units correctly.
- Before conducting an inspection, review the most recent plant inspection report.
- Use calculation sheets if observed values must be converted to the units of the permitted values.
- Note ranges of values if significant fluctuations are noted during the observation period.
- Use extra pages as necessary.
- Fill out all information as it is collected; don't depend on your memory. If information is not available, indicate that on the form.
- Document the sources of all information, especially if it pertains to potential permit violations. For example, did someone tell you something, did you personally observe it or did you read it in a file?

RCRA INCINERATOR INSPECTION
CHECKLIST NO. 1--PERMIT AND OPERATING CONDITIONS

I. ESSENTIAL INFORMATION

Facility ____________________ EPA ID No. ________________

Address ____________________
____
____

Facility Staff Involved (and Position) ________________
____
____
____
____
____

Primary Contact ______________
Phone No. ________________

Names of Inspectors (and Office) ______________________________
____
____

Dates of Visit ______________________
Time of Arrival __________________

Incinerator(s) Inspected ______________________________________
____
____
____

Permit Identification and Date of Issue ____________________________
(Date of most recent modification __________)

Operational Status of Incinerator(s) ______________________________
____
____
____

Date of Last Inspection ____________
(by State ___)
(by EPA ___)

Pending Enforcement Action ____________________________________
____
____
____

Previous Violations ____
____
____
____

Checklists Attached: No. 1 ____ (number of sets ____)
No. 2 ____
No. 3 ____

(Attach additional pages if necessary)

Description of incineration system (a block diagram showing the types and arrangement of equipment is recommended).

II. COMPARISON OF PERMIT AND OPERATING CONDITIONS

Date ______________________
Time Readings Began ____________
Time Readings Ended ____________

A. Permit Operating Parameters	Permitted Maximum (units)	Permitted Minimum (units)	Observed Reading(s) (units)	Calculated Value
1. Temperature measured at each combustion chamber exit				
a. Primary	NA	________	________	NA
b. Secondary	NA	________	________	NA
c.	NA	________	________	NA
d.	NA	________	________	NA
2. CO emissions measured at the stack or other appropriate location (location: ____________)	________________		________	________

- Does CO monitor automatically correct all readings to 7% O_2 based on actual O_2 stack concentration? ________yes ________no

If no, does permit require O_2 correction? ________ Does permit specify the correction factor to be used? ________ If so, list it. ________
Date correction factor last determined ________________ Describe any changes made in O_2 correction factor. ______________________

Permit-specified frequency for verifying O_2 correction factor ____________

- If a 60-minute rolling average is required, does the observed reading reflect a 60-minute rolling average?
  ________yes ________no ________not applicable
  If no, attach data and calculate the average. ____________

3. O_2 emissions (location): ____ (______________________)	________	________	________	________
4. Flue gas flow rate or velocity measured at stack or equivalent method: (______________)	________	NA	________	________

CHECKLIST NO. 1 (continued)

Permit Operating Parameters	Permitted Maximum (units)	Permitted Minimum (units)	Observed Reading(s) (units)	Calculated Value
5. Feed rate of each waste stream to each combustion chamber.				
Containerized waste feeds covered under item 10? _______yes _______no				
Chamber / Waste Stream (Name or Identifier)				
a. ______ __________	________	NA	________	________
b. ______ __________	________	NA	________	________
c. ______ __________	________	NA	________	________
d. ______ __________	________	NA	________	________
e. ______ __________	________	NA	________	________
f. ______ __________	________	NA	________	________
6. Pressure in primary chamber	________	________	________	________
7. Air pollution control:				
a. Liquid flow rate (or liquid/gas ratio) to absorber	NA	________	________	________
b. Nozzle pressure in absorber	________	________	________	________
c. pH of liquid to absorber	________	________	________	NA
d. Differential pressure across venturi scrubber	NA	________	________	________
e. Differential pressure across baghouse	________	________	________	________
f. kV values for ESP or ionizing wet scrubbers	NA	________ (minimum)	________	________
g. Current for ESP or ionizing wet scrubbers	NA	________ (minimum)	________	________

CHECKLIST NO. 1 (continued)

Permit Operating Parameters	Permitted Maximum (units)	Permitted Minimum (units)	Observed Reading(s) (units)	Calculated Value
h. Liquid flow rate to dry scrubber	NA	________	________	________
i. Nozzle pressure to dry scrubber	________	________	________	________
j. pH of liquid to dry scrubber	________	________	________	NA
k. Particulate scrubber blowdown rate	NA	________	________	________
l. Quench flow rate	NA	________	________	________
m. ________________	________	________	________	________
n. ________________	________	________	________	________
8. Inlet gas temperature to air pollution control devices				
a. ________________	________	________	________	NA
b. ________________	________	________	________	NA
c. ________________	________	________	________	NA

ID # ____________
Date ____________

CHECKLIST NO. 1 (continued)

9. Liquid injection burner settings:

	Chamber	Burner No.	Permitted Maximum Burner Feed Rate/ Turndown Ratio	Observed Burner Flow Rate	Nominal Burner Flow Rate	Calculated Burner Turndown	Permitted Minimum Atomization Fluid Pressure	Observed Atomization Fluid Pressure
a.								
b.								
c.								
d.								
e.								
f.								
g.								
h.								
i.								
j.								
k.								

ID # ____________
Date ____________

CHECKLIST NO. 1 (continued)

10. Containerized waste feed system limitations:

Chamber	Feed Rate	Permitted Container Type and Size	Observed Container Type and Size
a. ______	____________	____________ ____________ ____________	____________ ____________ ____________
b. ______	____________	____________ ____________ ____________	____________ ____________ ____________
c. ______	____________	____________ ____________ ____________	____________ ____________ ____________
d. ______	____________	____________ ____________ ____________	____________ ____________ ____________

CHECKLIST NO. 1 (continued)

Permit Operating Parameters	Permitted Maximum (units)	Permitted Minimum (units)	Observed Reading (units)	Calculated Value
11. Additional permit conditions				
a. ______________	______	______	______	______
b. ______________	______	______	______	______
c. ______________	______	______	______	______
d. ______________	______	______	______	______
e. ______________	______	______	______	______
f. ______________	______	______	______	______
g. ______________	______	______	______	______

ID # ____________
Date ____________

CHECKLIST NO. 1 (continued)

B. Characterization of wastes and fuels fed during the observation period

1. Organics and physical characterization

			Organic constituents (limitations, compounds, etc.)	Ash ( )	Chloride ( )	Viscosity ( )	Heating Value (Btu/lb)	Specific Gravity ( )	Other
(a)	**Combined waste stream limitations in permit**		____ ____ ____	____	____	____	____	____	____
(b)	**Limitations in permit for individual waste streams:**								
	Chamber	Waste Stream							
(1)	____	____	____ ____	____	____	____	____	____	____
(2)	____	____	____ ____	____	____	____	____	____	____
(3)	____	____	____ ____	____	____	____	____	____	____
(4)	____	____	____ ____	____	____	____	____	____	____
(5)	____	____	____ ____	____	____	____	____	____	____
(6)	____	____	____ ____	____	____	____	____	____	____

ID # ____________
Date ____________

CHECKLIST NO. 1 (continued)

	Organic constituents (limitations, compounds, etc.)	Ash ( )	Chloride ( )	Viscosity ( )	Heating Value (Btu/lb)	Specific Gravity ( )	Other ____
(c) **Analysis characteristics of combined waste stream**	____	____	____	____	____	____	____

(d) **Characterization of waste streams fed during inspection:** (Range of Dates of Analysis ____________)

	Chamber	Waste Stream	Organic constituents	Ash	Chloride	Viscosity	Heating Value	Specific Gravity	Other
(1)	____	____	____	____	____	____	____	____	____
(2)	____	____	____	____	____	____	____	____	____
(3)	____	____	____	____	____	____	____	____	____
(4)	____	____	____	____	____	____	____	____	____
(5)	____	____	____	____	____	____	____	____	____
(6)	____	____	____	____	____	____	____	____	____

ID # ____________
Date ____________

CHECKLIST NO. 1 (continued)

				Metals (Units ____									
				"Carcinogenic"				"Noncarcinogenic"					
2.	Metals			As	Cd	Cr	Be	Sb	Ba	Pb	Hg	Ag	Tl
(a)	**Combined waste stream limitations in permit**			____	____	____	____	____	____	____	____	____	____
(b)	**Limitations in permit for individual waste streams:**												
	Chamber	Waste Stream											
(1)	____	________		____	____	____	____	____	____	____	____	____	____
(2)	____	________		____	____	____	____	____	____	____	____	____	____
(3)	____	________		____	____	____	____	____	____	____	____	____	____
(4)	____	________		____	____	____	____	____	____	____	____	____	____
(5)	____	________		____	____	____	____	____	____	____	____	____	____
(6)	____	________		____	____	____	____	____	____	____	____	____	____

CHECKLIST NO. 1 (continued)

				Metals (Units ____)									
				"Carcinogenic"				"Noncarcinogenic"					
2.	Metals (continued)			As	Cd	Cr	Be	Sb	Ba	Pb	Hg	Ag	Tl
(c)	Analysis characteristics of combined waste streams			____	____	____	____	____	____	____	____	____	____
(d)	Characterization of waste streams fed during inspection:												
	Chamber	Waste Stream											
(1)	____	____		____	____	____	____	____	____	____	____	____	____
(2)	____	____		____	____	____	____	____	____	____	____	____	____
(3)	____	____		____	____	____	____	____	____	____	____	____	____
(4)	____	____		____	____	____	____	____	____	____	____	____	____
(5)	____	____		____	____	____	____	____	____	____	____	____	____
(6)	____	____		____	____	____	____	____	____	____	____	____	____

ID # ____________
Date ____________

CHECKLIST NO. 1 (concluded)

3. Auxiliary fuel and total heat input:

a.

Auxiliary Fuel Type of Fuel	Chamber	Observed Flow Rate (units)	Heating Value (units)	Heat Input from fuel (units)

b. Total heat input

	(units)
Permitted total heat input	
Observed fuel heat input	
Observed waste heat input	
Observed total heat input	

CHECKLIST NO. 2--VISUAL ASSESSMENT AND AUDIT ACTIVITIES FOR AN "IN-DEPTH" INSPECTION

I. VISUAL ASSESSMENT OF PERFORMANCE, OPERATIONS, AND ENVIRONMENTAL SAFETY

A. Observation of Equipment/Function [1, etc. = Problem note (see below)]

	Leaks/ Emissions	Seals	Structural Integrity	Proper Function	Safety Issues
--Waste unloading	____	____	____	____	____
--Waste storage/blending	____	____	____	____	____
--Waste handling/piping	____	____	____	____	____
--Waste feed/fuel systems	____	____	____	____	____
--Combustion chambers/burners	____	____	____	____	____
--Kiln drive system	____	____	____	____	____
--Combustion air fans	____	____	____	____	____
--Connecting ducts	____	____	____	____	____
--Pollution control devices					
•Absorber	____	____	____	____	____
•Venturi scrubber	____	____	____	____	____
•Ionizing wet scrubber	____	____	____	____	____
•Baghouse	____	____	____	____	____
•____________	____	____	____	____	____
--Emergency vent stack (dump stack)	____	____	____	____	____
--Process instrumentation	____	____	____	____	____
--Ash handling system	____	____	____	____	____
--Scrubber effluent handling	____	____	____	____	____
--____________	____	____	____	____	____

Notes

1.

CHECKLIST NO. 2 (continued)

B. Observed Operations [Give brief description of problem, or reference a Note below (1,2, etc.)]

	Status/Comments
--Records of permit parameters (complete, accessible)	____________
--Proper identification of date, time, and units on strip charts	____________
--Records of waste acceptance	____________
handling	____________
characterization	____________
--Log of inspections	____________
calibrations	____________
maintenance	____________
--Subjective evaluation of operators	____________
--Staff knowledge of emergency procedures	____________
contingencies	____________
--Handling/fate of residuals	____________
•Primary chamber ash	____________
•Scrubber effluent (_____)	____________
•Scrubber effluent (_____)	____________
•____________	____________
•____________	____________
--Appearance of stack emissions	____________
--____________	____________
--____________	____________
--____________	____________

Notes

1.

CHECKLIST NO. 2 (continued)

General Quality of Operation

Comments

--Odors

--Housekeeping

•Storage areas

•Waste feed areas

•Control room

•General facility

•Laboratory

--____________

--____________

--____________

ID # ____________
Date ____________

CHECKLIST NO. 2 (continued)

II. IN-DEPTH AUDITS AND DOCUMENTATION REVIEW

A. Audits of Equipment Function

1. Continuous Emission Monitors (CEMS)

Observe a calibration check by facility staff of each CEM required in the permit. Note the following:

a. Background information

Parameter	Instrument Manufacturer	Instrument Model No.	Extractive or in situ	Frequency of calibration	Manual or automatic calibration	Calibration reference* material
CO						
O_2						
________						
________						
________						

ID # ____________
Date ____________

CHECKLIST NO. 2 (continued)

b. Calibration

Parameter	Date/Time of Observation	Instrument Reading: "Zero"	Instrument Reading: Std. No. 1	Instrument Reading: Std. No. 2	Instrument Reading: Std. No. 3	Correction**	Certified Concentration of Reference Material*: Std. No. 1	Certified Concentration of Reference Material*: Std. No. 2	Certified Concentration of Reference Material*: Std. No. 3
CO	________	____	____	____	____	________	____	____	____
O_2	________	____	____	____	____	________	____	____	____
________									
________									
________									

* One reference for extractive monitors may be an "unknown" standard gas supplied by the inspector.
** Provide details in the space below about any correction factors applied to the readings.

c. Modifications

Has any instrument or sampling location been changed since the permit was issued/modified? Provide details.

CHECKLIST NO. 2 (continued)

2. Observe the operation of the automatic waste feed cutoff system in response to simulated upset conditions for each automatic cutoff condition required in the permit [Note: At least one test must involve an actual shutdown. *S = Simulated, A = Actual]:

Automatic Cutoff Conditions	Permit Limits Value	Permit Limits Time Lag	Observed Value	Observed Time Lag	S or A*	Adequate Function?
• Minimum temperature						
Chamber ( )						
Chamber ( )						
Chamber ( )						
• Maximum CO						
• Other CO limit						
• Maximum flue gas flow rate/velocity						
• Maximum feed rate (streams) ______						
______						
______						
______						
______						
• Pressure in primary combustion chamber						
• Air pollution control:						
______						
______						
______						
______						

CHECKLIST NO. 2 (continued)

Automatic Cutoff Conditions	Permit Limits Value	Permit Limits Time Lag	Observed Value	Observed Time Lag	S or A*	Adequate Function?
Other automatic shutdown conditions in permit:						
____________	______	______	______	______	______	______
____________	______	______	______	______	______	______
____________	______	______	______	______	______	______
____________	______	______	______	______	______	______

* Simulated (S) or actual (A) shutdown.

3. Review documentation of the most recent calibration of the monitoring instrumentation for all **permit operating parameters** specified in the permit. Discuss procedures used with the facility staff. (Provide notes for each parameters--attach note pages as applicable.)

te No.

______ • Temperature indicators (for each combustion chamber exit)

______ • Feed rate indicators (flowmeters, weigh scales)

______ • Combustion gas velocity indicator

______ • Flowmeters in APCE

______ • Pressure indicators in combustion chambers and APCE

______ • pH meter

______ • ____________

______ • ____________

CHECKLIST NO. 2 (continued)

B. Audits of Waste Characterization and Handling [1, etc. = Problem note (see below)]

Status

1. Review of Waste Characterization

   a. Analysis of appropriate parameters ____________
   b. Frequency of analysis ____________
   c. Adequate analysis documentation (subjective) ____________

2. Review of Waste Handling Documentation

   a. Waste acceptance

      - Manifest/Logs ____________
      - "Fingerprint" analysis ____________

   b. Blending/feeding logs ____________

3. Review of on-site laboratory (optional)

   a. Calibration records ____________
   b. Maintenance records ____________
   c. Availability of Analytical and QA/QC Procedures ____________

C. Review of Other Records Required by the Permit

1. Records of Dump Stack Openings

   - Openings documented: ___ incidents since ______ (date of last inspection) or ______ in last 12 months (reported to _____ state or _____ EPA)
   - Temperature maintained during openings ____________
   - Minimum airflow maintained during openings ____________
   - Causes ____
     ____
   - Corrective actions ____

2. Records of Automatic Waste Feed Cutoff (AWFCO)

   - Documented ____________
   - Frequency of cutoff incidents (_____ per month or _____ per day (average of _____ days)
   - Major causes for AWFCO ____
     ____
     ____

CHECKLIST NO. 2 (concluded)

3. Inspection Logs/Calibration Records

- Complete ____________
- Adequate schedule ____________
- Recurring problems ____

4. Maintenance Records

- Complete ____________
- Timely corrective action ____________
- Routine maintenance performed on schedule ____________
- Frequency? ____________
- Note any reoccurring maintenance problems ____________________
- List any equipment replaced since last inspection (obtain manufacturer's specifications) ____________________

D. Audit of Waste Analysis (optional)

- Provide check samples for analysis by the facility lab or obtain sample splits for return to agency labs (or agency contractor lab)
- Document the origin of each sample
- Identify the parameters for analysis, analysis methods, sampling handling/storage limitations, and any essential QA/QC requirements to be completed by the facility's lab and the agency lab (if applicable)

Notes:

ID # ____________
Date ____________

CHECKLIST NO. 3--VISUAL ASSESSMENT AND AUDIT ACTIVITIES FOR A "WALK-THROUGH" INSPECTION

I. VISUAL ASSESSMENT OF PERFORMANCE, OPERATIONS, AND ENVIRONMENTAL SAFETY

A. Observation of Equipment/Function [1, etc. = Problem note (see below)]

	Leaks/ Emissions	Seals	Structural Integrity	Proper Function	Safety Issues
--Waste unloading	____	____	____	____	____
--Waste storage/blending	____	____	____	____	____
--Waste handling/piping	____	____	____	____	____
--Waste feed/fuel systems	____	____	____	____	____
--Combustion chambers/burners	____	____	____	____	____
--Kiln drive system	____	____	____	____	____
--Combustion air fans	____	____	____	____	____
--Connecting ducts	____	____	____	____	____
--Pollution control devices					
•Absorber	____	____	____	____	____
•Venturi scrubber	____	____	____	____	____
•Ionizing wet scrubber	____	____	____	____	____
•Bag house	____	____	____	____	____
•____________	____	____	____	____	____
•____________	____	____	____	____	____
--Emergency vent stack (dump stack)	____	____	____	____	____
--Process instrumentation	____	____	____	____	____
--Ash Handling System	____	____	____	____	____
--Scrubber Effluent Handling	____	____	____	____	____
--____________________	____	____	____	____	____

Notes

1.

CHECKLIST NO. 3 (continued)

)bserved Operations [Give brief description of problem or reference a note below (1, 2, etc.)]

Status/Comments

--Records of permit parameters (complete, accessible) ______________

--Proper identification of date, time, and units on strip charts ______________

--Records of automatic waste feed cutoff (AWFCO)

- Documented ______________
- Frequency of cutoff incidents _____ per month or _____ per day (average of _____ days)
- Major causes for AWFCO ______________

--Records of dump stack openings

- Openings documented: _____ incidents since _________ (date of last inspection) or _______ in last 12 months (reported to _____state or _____EPA)
- Temperature and airflow maintained ______________
- Causes ______________
- Corrective actions ______________

--Records of waste acceptance ______________
handling ______________
characterization ______________

--Log of inspections ______________
calibrations ______________
maintenance ______________

--Staff knowledge of emergency procedures ______________
contingencies ______________

--Appearance of stack emissions ______________

--______________ ______________

--______________ ______________

Notes

1.

CHECKLIST NO. 3 (continued)

C. General Quality of Operation

Comments

--Odors

--Housekeeping

•Storage areas

•Waste feed areas

•Control room

•General facility

--Laboratory

--______________

--______________

--______________

ID # ____________
Date ____________

CHECKLIST NO. 3 (continued)

II. QUICK AUDIT OF PERFORMANCE

1. Continuous Emission Monitors (CEMS)

Observe a calibration check by facility staff of each CEM required in the permit. Note the following:

a. Background information

Parameter	Instrument: Manufacturer	Instrument: Model No.	Extractive or in situ	Frequency of calibration	Manual or automatic calibration	Calibration reference* material
CO						
O_2						
________						
________						
________						

ID # ____________
Date ____________

CHECKLIST NO. 3 (continued)

b. Calibration

		Instrument Reading					Certified Concentration of Reference Material*		
Parameter	Date/Time of Observation	"Zero"	Std. No. 1	Std. No. 2	Std. No. 3	Correction**	Std. No. 1	Std. No. 2	Std. No. 3
CO									
O_2									

* One reference for extractive monitors may be an "unknown" standard gas supplied by the inspector.
** Provide details in the space below about any correction factors applied to the readings.

c. Modifications

Has any instrument or sampling location been changed since the permit was issued/modified? Provide details.

CHECKLIST NO. 3 (concluded)

. Observe the operation of the automatic waste feed cutoff system in response to one or more simulated or actual upset conditions. At least one observation should include an actual shutdown.

Parameter Demonstrated	Permit Limit Value	Observed Value	Actual or Simulated	Adequate Function?

APPENDIX B

CALCULATIONS

This appendix contains calculations that inspectors may need to perform as part of incinerator inspections. Inspectors may need to complete two types of calculations in order to compare actual operating conditions/activities at an incinerator with limitations specified in the facility's permit.

The first type of problem is essentially a unit conversion. These will be needed whenever permit-limited parameters are monitored and logged in units or forms that differ from those specified in the permit. Conversions may include:

- English system/metric system conversions.
- Mass/volume conversions.
- Converting monitored conditions to standard conditions.
- Calculating a ratio comparison of monitored and design conditions.
- Other similar conversions.

These types of calculations are demonstrated in Problem Nos. 1 and 2 in this appendix.

The second type of calculation involves waste characterization data. These data are recorded typically as concentrations (mg/L) or in a similar form (Btu/lb). Typically, inspectors will need to convert some of these values into a loading rate (lb/hr, Btu/hr, etc.) to allow a direct comparison with specified permit conditions. Problem Nos. 3 to 5 address this type of calculation.

The conversion chart provided below lists factors that may be needed by inspectors to complete calculations in the field:

Conversions

English	Metric
1 lb	454 g
1 atm	760 mm Hg
35.3 ft^3	1,000 L (or 1 m^3)
1 gal	3.785 L
(°F-32) x 5/9	°C

Misc.

1 atm = 14.7 psi = 29.92 in Hg
Density of water = 62.4 lb/ft^3 or 8.34 lb/gal (at 60°F)
= 1 g/cm^3 at 0°F

1. SPECIFIC GRAVITY AND DENSITY

- Density = mass per unit volume (ρ)

  lb/ft^3
  lb/gal
  g/cm^3

- Specific gravity = ratio of two densities with H_2O being the reference fluid (unitless)

- Specific gravity Compound A = $\frac{\text{Density of A}}{\text{Density of } H_2O}$

- Key constants or conversion values

Density of H_2O = 62.4 lb/ft^3 or 8.34 lb/gal (at 60°F) or 1 g/cm^3 (at 4°C)
1 lb = 454 g
35.3 ft^3 = 1 m^3 = 1,000 L

Examples

a. What is the density of a liquid waste feed with a specific gravity of 0.86?

$$\begin{aligned}\text{Density Waste} &= (\text{Sp. Gr. Waste})(\text{Density of } H_2O)\\ &= (0.86)(8.34 \text{ lb/gal})\\ &= 7.17 \text{ lb/gal}\end{aligned}$$

b. A 55-gal drum contains a sludge with a specific gravity of 1.2. What is the total weight of the contents (in lb)?

$$\begin{aligned}\text{Density Waste} &= (\text{Sp. Gr. Waste})(\text{Density of } H_2O)\\ &= (1.2)(8.34 \text{ lb/gal})\\ &= 10.0 \text{ lb/gal}\end{aligned}$$

$$\begin{aligned}\text{Weight} &= (\text{Density})(\text{Volume})\\ &= 10 \text{ lb/gal} \cdot 55 \text{ gal}\\ &= 550 \text{ lb}\end{aligned}$$

2. VOLUMETRIC FLOW RATES AND IDEAL GAS LAW

- Gas volumes typically measured at either standard conditions or actual conditions. Permit limits may also be stated in either standard or actual conditions.

- Standard conditions:

  -- SI: $T = 20°C$, $P = 1$ atm

  -- English: $T = 68°F$, $P = 29.92$ in Hg

- Use ideal gas law to translate between actual and standard conditions:

$$PV = nRT \text{ or } \frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

P = absolute pressure (atm, psi, in Hg, in H_2O)
V = volume (ft^3, m^3)
T = absolute temperature (K, °R)
n = number of moles
R = ideal gas law constant (appropriate units)

- Temperature conversions

°F+460 = °R (degrees rankine)
°C+273 = K (degrees kelvin)

<u>Example</u>

Convert a stack gas flow rate of 10,000 acfm at 200°F, 28.9 in Hg to standard conditions.

$$\frac{P_{std}V_{std}}{T_{std}} = \frac{P_{act}V_{act}}{T_{act}}$$

$$V_{std} = \frac{P_{act}T_{std}}{T_{act}P_{std}} V_{act}$$

200°F = 660°R
68°F = 528°R

$$= \frac{(28.9 \text{ in Hg})(528°R)}{(660°R)(29.92 \text{ in Hg})} (10{,}000 \text{ ft}^3/\text{min})$$

= 7,700 cfm (standard conditions)

3. HEATING VALUE

- Higher heating value (HHV) = enthalpy change or heat released when a fuel is stoichiometrically combusted at 60°F with final products at 60°F and water in a liquid state.

- Thermal input = mass feed rate x higher heating value.

- For multiple feed streams:

$$\text{Heat input} = \sum_{i=1}^{n} M_i x HHV_i \quad \text{where}$$

M_i = mass feed rate of stream i (lb/hr)

HHV_i = higher heating value of stream i (Btu/lb)

Example

Waste stream A has a heating value of 5,000 Btu/lb, waste B has a heating value of 850 Btu/lb, and auxiliary natural gas has a heating value of 1,100 Btu/ft³. An incinerator burns 500 lb/hr of waste A, 730 lb/hr for waste B, and uses 25,000 ft³/day of natural gas. What is the hourly heat input to the incinerator?

$$\text{Heat Input} = M_A \times HHV_A + M_B \times HHV_B + M_C \times HHV_C$$

$$= 500 \text{ lb/hr} \times 5{,}000 \text{ Btu/lb} + 730 \text{ lb/hr} \times 850 \text{ Btu/lb} + 25{,}000 \text{ ft}^3\text{/day} \times 1 \text{ day/24 hr} \times 1{,}100 \text{ Btu/ft}^3$$

$$= 4.27 \times 10^6 \text{ Btu/hr}$$

4. HEATING VALUES AND BURNER TURNDOWN

Background: An on-site industrial facility has a liquid injection incinerator dedicated to a particular process. Typically the facility burns still bottoms from the process using three burners whose specifications are attached. The still bottoms have an average heating value of 6,500 Btu/lb and a specific gravity of 0.90. The burners have a nominal rating of 15 gal/min and a permitted maximum turndown ratio of 3:1. (Burner turndown is a ratio of design burner flow to actual burner flow rate.) During the trial burn, the facility ran waste still bottoms through all three burners at a rate of 11 gal/min. The incinerator is rated at a maximum thermal capacity of 100 x 10^6 Btu/hr and that rated level is established as a permit limit.

Problem: The plant has produced an off-spec product that has the same Appendix VIII constituents as the still bottoms. This material is ignitable and has a specific gravity of 0.87 and a heating value of 17,500 Btu/lb. The plant is disposing of the product in the incinerator at the rate of 1,800 lb/hr through one burner. The other two burners are burning still bottoms at the rate of 12 gal/min.

--Is the plant in compliance with burner turndown limits?
--Is the plant in compliance with its maximum heat input limits?

Solution to "Heating Value and Burner Turndown" Problem

1. Calculate the density of the off-spec liquid

Density liquid = specific gravity x density H_2O
= 0.87 x 8.34 lb/gal
= 7.26 lb/gal

2. Calculate the liquid flow rate in gal/min

$$Q \text{ (gal/min)} = \frac{1{,}800 \text{ lb}}{\text{h}} \cdot \frac{1 \text{ h}}{60 \text{ min}} \cdot \frac{1 \text{ gal}}{7.26 \text{ lb}}$$

= 4.1 gal/min

3. Calculate turndown ratio

$$\text{Turndown} = \frac{\text{Nominal flow}}{\text{Actual flow}}$$

$$= \frac{15}{4.1} = 3.7{:}1$$

*** Hence the flow is outside limits**

4. Calculate density of bottoms

Density bottoms = specific gravity x density H_2O
= 0.9 x 8.34 lb/gal
= 7.51 lb/gal

5. Calculate heat inputs

Heat input bottoms = 24 gal/min x 7.51 lb/gal x 6,500 Btu/lb x 60 min/hr
= 70.3×10^6 Btu/hr

Heat input off-spec materials = 1,800 lb/hr x 17,500 Btu/lb
= 31.5×10^6 Btu/hr

Total heat input = $70.3 \times 10^6 + 31.5 \times 10^6$
= 101.8×10^6 Btu/hr

*** Hence the heat input exceeds the permit limit**

5. ASH AND CHLORIDE INPUT RATES

A small liquid injection incinerator has only a packed-bed scrubber for air pollution control. The scrubber has been found to be only about 90% efficient for HCl control. Consequently the chloride input rate is limited to 30 lb/hr and ash input to the incinerator is limited to 2.5 lb/hr. A review of the records show that over a 2-week period the plant burned waste A at the rate of 2.5 gal/min and waste B at the rate of 10 gal/min. These wastes had the following properties:

Type	Waste A Organic	Waste B Aqueous
Heating value (Btu/lb)	15,000	600
Organic chlorine	3.2%	0.1%
Ash content	0.06%	0.05%
Specific gravity	0.9	1.0

Was the system in compliance with the ash and chloride limits in the permit?

Solution to "Ash Chloride Input Rates" Problem

1. Calculate densities of feeds

   Density A = 0.9 x 8.34 lb/gal = 7.51 lb/gal
   Density B = 8.34 lb/gal

2. Calculate mass feed rates

   $\dot{M}_A$ = 2.5 gal/min x 7.51 lb/gal x 60 min/hr = 1,130 lb/hr

   $\dot{M}_B$ = 10 gal/min x 8.34 lb/gal x 60 min/hr = 5,000 lb/hr

3. Calculate chloride input rates

$$Cl_{total} = \dot{M}_A \frac{\%Cl_A}{100} + \dot{M}_B \frac{\%Cl_B}{100}$$

   = 1,130 (0.032) + 5,000 (0.001)

   = 41 lb/hr

*** Hence the chloride input exceeds the permit limit**

4. Calculate ash input rates

$$\text{Ash total} = \dot{M}_A \frac{\%\text{ ash in A}}{100} + \dot{M}_B \frac{\%\text{ ash in B}}{100}$$

   = 1,130 (0.006) + 5,000 (0.0005)

   = 3.2 lb/hr

*** Hence the ash input exceeds the permit limit**

APPENDIX C

DRAFT MODEL INCINERATOR PERMIT

MODULE IX(A) - INCINERATION

[Note: This module, plus Module IX(B) for Short-Term Incineration, covers the four major phases of incineration operation: (1) shakedown; (2) trial burn; (3) post-trial burn operation; and (4) final operation. This module provides the conditions for final operation for both existing and new incineration units. The Short-Term Incineration Module covers the shakedown, trial burn, and post-trial burn operating phases for new incineration units only. These phases of operation are discussed in 40 CFR 264.344(c).]

[Note: This module is not used for incineration units that qualify for an automatic exemption under 40 CFR 264.340(b). These units must comply only with the waste analysis and closure requirements. For units that are granted an exemption under 40 CFR 264.340(c), parts of this module may be appropriate to use on a case-by-case basis. The Permit Writer should document the basis for granting exemptions in the Administrative Record for this facility.]

[Note: For facilities with more than one incineration unit, a separate permit module should be used for each unit.]

[Note: Waste analysis requirements (40 CFR 264.13) and closure requirements (40 CFR 264.197) for incineration units are generally contained as attachments to the Permit in the Waste Analysis Plan and Closure Plan. The Waste Analysis Plan and Closure Plan must cover the requirements of 40 CFR 264.341 and 40 CFR 264.351, respectively, in accordance with 40 CFR 264.340(b).]

[Note: For new incinerators, some permit conditions will initially be tentative and will need to be finalized after the trial burn results have been evaluated. In this module, the conditions that may be subject to change for new incinerators are marked with an asterisk (*). In crafting actual permit conditions, the Permit Writer should mark tentative conditions with an asterisk, or other designation, and include a note such as the following...*The number in this permit condition is tentative and will be made final after the trial burn results have been evaluated. In the case of maximums, EPA reserves the right to specify any number less than this value as the shut-off limit. In the case of minimums, EPA reserves the right to specify any value higher.]

[Note: The Permit Writer should refer to the RCRA Permit Quality Protocol for additional guidance in developing or reviewing permit conditions. See discussion of the RCRA Permit Quality Protocol in the Introduction to this Model Permit.]

IX(A).A. <u>MODULE HIGHLIGHTS</u>

[The Permit Writer should include a general discussion of the activities covered by this module. The discussion may include some or all of the following information: type of incineration system; types of air pollution control equipment used; system capacity in terms of either heat rate or mass flow rate; key operating conditions, such as combustion temperature (and whether these conditions were based on trial burn results, or data in lieu of a trial burn); a general description of the automatic waste feed cut-off system; the types of waste that may be burned; the principal organic hazardous constituents selected and the rationale for this selection; any unique or special features associated with the operation; and a reference to any special permit conditions.]

IX(A).B. <u>IDENTIFICATION CRITERIA FOR PERMITTED AND PROHIBITED WASTE</u>

[Note: There are two general options for identifying the allowable waste feed to the incinerator, pursuant to 40 CFR 264.344(a). The first option covers situations where it is not practical to name all the wastes that a facility might be permitted to burn. This is a common situation for a commercial off-site facility. In this case, the Permit Writer should identify a set of criteria that establishes limitations on the general physical and chemical characteristics of the waste feed to the incinerator. The second option is most appropriate for incinerators that are used to burn waste from specific processes, such as on-site incinerators. Here, it is usually possible to identify the specific wastes or classes of wastes that the Permittee shall be permitted to burn. For example, a manufacturer of Freon might be permitted to burn the chlorofluorocarbon POHC and other related wastes associated with the production process. Examples of recommended language addressing these two options are presented in Permit Conditions IX(A).B.1. and IX(A).B.2.]

Except during the periods specified in the conditions for Short-Term Incineration under Shakedown Period, Trial Burn and Post-Trial Burn, the Permittee may incinerate the following hazardous wastes, as specified in this Permit and only under the terms of this Permit. The Permittee may only feed the hazardous wastes as identified below [or in Permit **Attachment <u>IX(A)-1</u>, List of Wastes**] at the facility subject to Permit Conditions IX(A).C. through IX(A).F., and IX(A).H.

IX(A).B.1. **[Option 1. - Off-Site Commercial Facility: Include the following conditions for each waste stream.]** The Permittee shall incinerate only hazardous wastes meeting the following criteria:

- o No hazardous constituents shall have a heat of combustion less than that of ______________ [POHC] (______ BTU/lb).

  [Note: Using the heat of combustion method of incinerability ranking, the specified POHC should be the facility's POHC with the lowest heat of combustion. It should be noted that other methods of incinerability ranking, such as thermal stability at low oxygen are available. (See preamble to proposed incineration amendments, Summer 1988.) Use of another ranking system in addition to, or instead of, heat of combustion would require modification of this model condition.]

- o The ash content of the waste shall be no greater than ___ percent by weight.*

- o The total halide content of the waste shall be no greater than ______ percent by weight.*

- o The physical state of the waste feed shall be __ _______. [specify solid or liquid]

- o No waste, or combination of wastes, with a heating value of less than _______ BTU/lb [or other appropriate unit of measure], shall be fed to the secondary chamber of the incinerator [or (in the case of a single chamber liquid injection incinerator) to the incinerator] unless fed in conjunction with auxiliary fuel.

- o The viscosity of waste fed to the secondary chamber [or incinerator, in the case of single chamber liquid injection incinerator] burner number _____ shall not exceed _______ cp.

IX(A).B.2. [Option 2 - On-Site Facility] The Permittee may incinerate only the following hazardous wastes:

Hazardous Waste No.	Description	Feed Rate
[Example: D003, D004, D008	**Freezon 123b reactor bottoms ("Tars")**	**(Specify rate of input in appropriate units--lb/hr)**
D001	**Freezon 122b rich liquid**	**(Specify rate of input in appropriate units--lb/hr)]**

[Note: The Permit Writer may impose other limitations, such as those under Option 1 above, on the waste feed, as necessary, to ensure compliance with the performance standards of 40 CFR 264.343. All such limitations, however, should be derived from the results of the trial burn or from the data submitted in lieu of a trial burn, or for conditions such as waste feed viscosity, from the burner manufacturer's specifications.]

IX(A).B.3. Throughout operation, the Permittee shall conduct sufficient analysis in accordance with the Waste Analysis Plan, Permit Attachment II-1, to verify that waste fed to the incinerator is within the physical and chemical composition limits specified in this Permit.

[Note: The Permit Writer may also include here a list of specific wastes or materials that are prohibited.]

IX(A).C. CONSTRUCTION, INSTRUMENTATION, AND OPERATIONAL PERFORMANCE REQUIREMENTS

[Note: Permit Condition IX(A).C.1. applies only to new facilities; Permit Condition IX(A).C.2. applies only to existing facilities.]

IX(A).C.1. The Permittee shall construct and maintain the incinerator in accordance with the design plans and specifications contained in Permit Attachment IX(A)-2. The Permittee shall not feed hazardous wastes to the incinerator until Permit Condition I.E.12 (Certification of Construction or Modification) has been complied with.

IX(A).C.2. The Permittee shall maintain the incinerator in accordance with the design plans and specifications contained in Permit Attachment IX(A)-2.

[Note: 40 CFR 264.345(b)(5) requires that the Permit specify any allowable variations in system design during the operation of the incinerator. The Permit Writer should develop additional conditions, as necessary, to cover these variations and/or provide a description of these variations as an attachment to the Permit, Permit Attachment IX(A)-3.]

IX(A).C.3. The Permittee shall install and test all instrumentation in accordance with the design plans, performance specifications, and maintenance procedures contained in Permit Attachment IX(A)-2 prior to handling hazardous wastes in the incinerator unit.

The Permittee shall [design, construct, and] maintain the incinerator so that when operated, in accordance with the operating requirements specified in this permit, it will meet the performance standards specified in Permit Conditions IX.(A).C.4. through IX.(A).C.6. [40 CFR 264.343]

IX(A).C.4. The incinerator shall achieve a destruction and removal efficiency (DRE) of 99.99 percent for each of the following principal organic hazardous constituents (POHC) for each waste feed. The DRE value shall be determined using the method specified in 40 CFR 264.343(a)(1). [40 CFR 264.343(a)(1)]

[Note: Any incinerator burning hazardous wastes F020, F021, F022, F023, F026, or F027 must achieve a DRE of 99.9999 percent for each designated POHC. These POHCs, designated by the Permit Writer, must be more difficult to incinerate than tetra-, penta-, and hexachlorodibenzo-p-dioxins and dibenzofurans.] [40 CFR 264.343(a)(2)]

Waste Feed	POHC(s)
________________	________________
________________	________________
________________	________________
________________	________________
________________	________________

IX(A).C.5. The Permittee shall control hydrogen chloride (HCl) emissions, such that the rate of emissions is no greater than the larger of either 1.8 kilograms per hour (4 pounds/hour) or one percent of the HCl in the stack gas, prior to entering any pollution control equipment. [40 CFR 264.343(b)]

IX(A).C.6. The incinerator shall not emit particulate matter in excess of 180 milligrams per dry standard cubic meter (0.08 grains per dry standard cubic foot) when corrected for the amount of oxygen in the stack gas, in accordance with the formula specified in 40 CFR 264.343(c). [40 CFR 264.343(c)]

[Note: The Permit Writer should add the appropriate correction procedure to this condition in cases where a facility operates under conditions of oxygen enrichment. [40 CFR 264.343(c)]

[Note: 40 CFR 264.345(b)(1)-(4) requires the Permit Writer to establish operating limits for carbon monoxide, waste-feed rate, combustion temperature, and a combustion gas velocity indicator. Permit Conditions IX(A).C.7. through IX(A).C.10. cover those requirements. 40 CFR 264.345(b)(6) requires the Permit Writer to establish any other operating requirements (conditions) necessary to ensure compliance with the performance standards. Permit Conditions IX(A).C.11. through IX(A).C.22. are example permit conditions that serve this purpose. These permit conditions incorporate the list of key operating parameters provided by the EPA Guidance on Trial Burn Reporting and Setting Permit Conditions. This guidance should be consulted for assistance in determining which of these conditions apply for a specific facility and the specific method of setting each condition, given the design and operation of the facility and the results of the trial burn or data in lieu of a trial burn.]

Except during the periods specified in the Permit Conditions for Short-Term Incineration under the Shakedown Period, Trial Burn Period, and Post-Trial Burn Period, the Permittee shall feed the wastes described in Permit Condition IX(A).B. to the incinerator only under the following conditions: [40 CFR 264.345]

IX(A).C.7. Carbon monoxide concentration in the stack exhaust gas, monitored as specified in Permit Condition IX(A).E., and corrected for the amount of oxygen in the stack gas, shall not exceed ____ ppm over a one hour rolling average **[or under the alternative format for CO limits, ___ ppm at any time, or ___ ppm for more than ____ minutes in any clock hour]**.*

IX(A).C.8. The Permittee shall be limited to the following waste feed rates in the following locations:

[Note: The Permit should specify the feed rate of each waste stream type (i.e., solid waste, organic liquid waste) to each combustion chamber. The following are example conditions. The Permit Writer shall select the condition(s) that are most appropriate for the Permit being prepared.]

(a) Maximum primary chamber organic liquid waste feed rate of ________ lb/hr.*

(b) Maximum primary chamber aqueous waste feed rate of ______ lb/hr.*

(c) Maximum primary chamber solid waste feed rate of ________ lb/hr.*

(d) Maximum secondary chamber organic liquid waste feed rate of ________ lb/hr.*

(e) The size of waste containers fed to the primary chamber shall not exceed ______ gallons of capacity.*

IX(A).C.9. Combustion temperature, monitored as specified in Permit Condition IX(A).E., shall be maintained at ___ °F (or °C) or greater.*

[Note: For dual-chamber incinerators, a minimum temperature should be set for each chamber.]

IX(A).C.10. Combustion gas velocity, monitored as specified in Permit Condition IX(A).E., shall be no greater than ____ ft/s.*

IX(A).C.11. The mass feed rates of toxic metals to the incinerator shall not exceed:

Arsenic:	_____	(grams/min)	Antimony:	_____	(grams/min)
Barium:	_____	(grams/min)	Lead:	_____	(grams/min)
Chromium:	_____	(grams/min)	Mercury:	_____	(grams/min)
Beryllium:	_____	(grams/min)	Silver:	_____	(grams/min)
Cadmium:	_____	(grams/min)	Thallium:	_____	(grams/min)

[Note: An option to Permit Condition IX(A).C.11., which would be more straightforward to enforce, is to set the limit on the actual concentration of metals in the waste feed. Then only the concentration value is required to determine compliance, rather than the concentration and waste feed rate at a specific point in time. However, this approach provides the Permittee with less flexibility to feed higher concentrations of metals when operating the incinerator at low feed rates.

IX(A).C.12. Atomization fluid pressure (e.g., steam, air) shall be no less than _____ psig.

IX(A).C.13. The turndown ratio for the waste burner shall be no greater than _____.

[Note: Permit Conditions IX(A).C.14. through IX(A).C.16 relate to ensuring compliance with the HCl emission standard in 40 CFR 264.343(b). The Permit Writer must determine which conditions are appropriate for a specific facility depending on the control devices present.]

IX(A).C.14. The $\frac{L}{G}$ ratio to the absorber, monitored as specified in Permit Condition IX(A).E., shall be maintained at no less than ___ **[sometimes expressed as gals per thousand cubic feet though usually dimensionless]**.*

IX(A).C.15. The scrubber effluent pH, monitored as specified in Permit Condition IX(A).E., shall be maintained at a minimum pH of ___.*

IX(A).C.16. The scrubber water delivery (nozzle) pressure, monitored as specified in Permit Condition IX(A).E., shall be maintained at no less than ___ psig.

[Note: Permit Conditions IX(A).C.17. through IX(A).C.22. relate to ensuring compliance with the particulate emission standard in 40 CFR 264.343(c). Note, however, that most facilities will not have all of the devices mentioned. The Permit Writer must determine which conditions are appropriate for a specific facility.]

IX(A).C.17. Pressure drop across the venturi scrubber, monitored as specified in Permit Condition IX(A).E., shall be maintained at no less than ___ psi.*

IX(A).C.18. The scrubber blowdown rate shall be maintained at no less than _____ gpm.*

IX(A).C.19. The power to the electrostatic precipitator, monitored as specified in Permit Condition IX(A).E., shall be maintained at no less than ___ kVA.*

IX(A).C.20. The voltage applied to the ionizing wet scrubber, monitored as specified in Permit Condition IX(A).E., shall be no less than _____ kV.*

IX(A).C.21. Pressure drop across the baghouse, monitored as specified in Permit Condition IX(A).E., shall be no less than ___ psi, nor greater than ____ psi.*

[Note: The Permit Writer may require the Permittee to specify in the Contingency Plan, provisions for maintaining and replacing bags.]

IX(A).C.22. The Permittee shall control fugitive emissions from the combustion zone of the incinerator by maintaining the pressure in the primary combustion chamber, monitored as specified in Permit Condition IX(A).E., to not exceed _____ inches of mercury. [40 CFR 264.345(d)]

[Note: The Permit Writer may specify another method for controlling fugitive emissions. The method must be demonstrated in the Part B Permit Application; this information should be attached to the Permit, Permit Attachment IX(A)-4, and referenced.]

IX(A).C.23. Compliance with the operating conditions specified in Permit Conditions IX(A).C.7. through IX(A).C.22. will be regarded as compliance with the required performance standards in Permit Conditions IX(A).C.4. through IX(A).C.6. However, evidence that compliance with these operating conditions is insufficient to ensure compliance with the performance standards, may justify modification, revocation, or reissuance of the Permit pursuant to 40 CFR 270.41. [40 CFR 264.343(d)]

[Note: It must be understood, by both the Permit Writer and Permittee, that violation of the permit operating conditions can give rise to an enforcement action. If the Permittee complies with the permit

operating conditions, but it is later shown that the performance standards are not being achieved, the permit may be modified or revoke and reissued, but enforcement actions are not available. Thus, each set of operating conditions should directly relate to achieving the performance standards in 40 CFR 264.343.]

IX(A).D. INSPECTION REQUIREMENTS

The Permittee shall inspect the incineration unit in accordance with the Inspection Schedule, Permit Attachment II-3, and shall complete the following as part of these inspections:

IX(A).D.1. The Permittee shall thoroughly, visually inspect the incinerator and associated equipment (including pumps, valves, conveyors, pipes, etc.) for leaks, spills, fugitive emissions, and signs of tampering. [40 CFR 264.347(b)]

IX(A).D.2. The Permittee shall thoroughly, visually inspect the instrumentation for out-of-tolerance monitored and/or recorded operational data.

IX(A).D.3. The Permittee shall test the emergency waste feed cut-off system and associated alarm at least weekly to verify operability, as specified in Permit Condition IX(A).E.1. [40 CFR 264.347(c)]

[Note: If the Permittee demonstrates to the Regional Administrator that the weekly inspections referred to in Permit Condition IX(A).D.3 will unduly restrict or upset operations and that less frequent inspection will be adequate, the Permit Writer should specify that inspection frequency in the permit condition. At a minimum, operational testing must be conducted at least monthly.]

IX(A).E. MONITORING REQUIREMENTS

IX(A).E.1. The Permittee shall maintain, calibrate, and operate monitoring equipment and record the data while incinerating hazardous waste, as specified below:

System Parameter	Monitor Type, Instr. No.	Location	Recording Process	Calibration Frequency
Examples (1) Combustion Tempera-	Type K Thermocouple TIC-900	[Us design drawing numbers to show the location]	[Indicate whether continuous or not]	[Frequency at which the unit is calibrated
(2) Pressure drop across scrubber venturi	Pressure Sensor PDIC-1220			

[Note: At a minimum, this condition must specify monitoring systems that meet the requirements of 40 CFR 264.347(a)(1) and (2). Permit Condition IX(A).E.1. contains example specifications for various operating parameters that must be monitored. Specific parameters should be addressed in the above table. If the Part B Permit Application contains the above information on monitoring practices, in a conveniently organized way and adequately detailed, then the Permit Writer may attach this information, Permit Attachment IX(A)-5, to the Permit instead of using a table in this permit module, and reference the attachment.]

IX(A).E.2 Upon request of the Agency, the Permittee shall perform sampling and analysis of the waste and exhaust emissions to verify that the operating requirements established in the Permit achieve the performance standards. [40 CFR 264.347(a)(3)]

IX(A).F. WASTE FEED CUT-OFF REQUIREMENTS

IX(A).F.1. The Permittee shall construct and maintain the systems specified below to automatically cut off the hazardous waste feed to the incinerator at the levels specified below. Hazardous wastes shall be fed to the incinerator only when all instruments required by this condition are on line and operating properly.

Parameter	Cut-Off Limits	Test Frequency
Operating parameters to be inter-locked to automatic waste-feed cut off i.e., SCC temper-ature]	[Level at which waste feed will be cut off]	[Frequency at which opera-tional readiness is checked]

[Note: 40 CFR 264.345(e) requires such systems to be constructed to ensure that the operating conditions specified in the Permit are not exceeded. Most cut-off systems are composed of multiple parameters. They include monitors for the operating conditions presented in Permit Condition IX(A).C. along with power failure and flame-out. If the Part B Permit Application adequately provides the above information regarding the automatic waste-feed cut-off system in an organized way and adequately detailed, then the Permit Writer may attach this information, Permit Attachment IX(A)-6, to the Permit, in lieu of using a table in this permit module, and reference the attachment.]

IX(A).F.2. In case of a malfunction of the automatic waste feed cut-off systems, the Permittee shall perform manual shut downs in accordance with the approved procedures in Permit Attachment IX(A)-7. The Permittee shall not restart the incinerator until the problem causing the malfunction has been located and corrected.

IX(A).G. CLOSURE

The Permittee shall follow the procedures in the Closure Plan, Permit Attachment II-9. [40 CFR 264.351]

IX(A).H. RECORDKEEPING

IX(A).H.1. The Permittee shall record and maintain, in the operating record for this permit, all monitoring and inspection data compiled under the requirements of this Permit (see Permit Condition I.E.9.b.). [40 CFR 264.73 and 40 CFR 264.347(d)]

IX(A).H.2. The Permittee shall record in the operating record for this permit the date and time of all automatic waste feed shut-offs, including the triggering parameters, reason for the shut-off, and corrective actions taken. The Permittee shall also record all failures of the automatic waste feed shut-offs to function properly and corrective actions taken.

IX(A).I. COMPLIANCE SCHEDULE

[Note: The Permit Writer should include this condition if the Permittee is required to complete specific steps within a specific time period, beyond those covered by other conditions of the Permit, as a criteria for retaining this operating Permit. Compliance schedules are generally used in cases where requirements that are supposed to be met by the Permittee, before the Permit is issued, are deferred for good cause until after permit issuance. Compliance schedules included in the Part B Permit Application should be attached to the Permit. If the application does not include a compliance schedule, the Permit Writer should prepare one and attach it to the Permit. Each compliance schedule should have at least two columns - one identifying the activity and one identifying the milestone or completion dates. The following is an example of a condition that may apply for incineration units.]

The Permittee shall provide the following information to the Regional Administrator:

Item	Date Due to the Regional Administrator
[Example:	
1. Documentation that thermocouple No. TC 2 was installed as shown on Drawing No. 960, dated March 18, 1987	May 12, 1989
2. As-built construction drawings for installation of Pressure Sensor No. PS 4	February 13, 1989]

PERMIT ATTACHMENTS REFERENCED IN MODULE IX(A) - INCINERATION

This list is provided to assist the Permit Writer in checking that all Permit Attachments referenced in this module are attached to the Permit. The purpose of the numbering scheme used here is to facilitate cross-walking with the model permit conditions. The Permit Writer may select other numbering schemes, as appropriate, when preparing actual Permits.

Permit Attachment No.	Plan or Document (from the Part B Permit Application)
II-1	Waste Analysis Plan
II-3	Facility Inspection Schedule
II-9	Closure Plan
IX(A)-1	List of Allowable Wastes
IX(A)-2	Design Plans and Specifications, and Maintenance Procedures
IX(A)-3	Description of Allowable Variations in System Design
IX(A)-4	Description of Procedures for Controlling Fugitive Emissions
IX(A)-5	Description of Monitoring Systems
IX(A)-6	Description of Automatic Waste Feed Cut-Off Systems
IX(A)-7	Description of Manual Waste Feed Cut-Off Systems

MODULE IX(B) - SHORT-TERM TEST INCINERATION

[Note: This permit module is applicable to facilities that perform a trial burn and presents conditions that, during the periods specified, supersede certain conditions found in Permit Module IX(A). 40 CFR 270.62 and 264.344(c) requires that a permit establish conditions necessary to meet the requirements of 40 CFR 264.345 during the shakedown, trial burn, and post trial burn periods.]

[Note: The purpose of this module is to provide permit conditions for the operation of a new incineration unit prior to the long-term operation period in order to:

1. Determine operational readiness following completion of physical construction;

2. Test compliance with the performance standards;

3. Determine adequate operating conditions to ensure that the performance standards will be maintained; and

4. Control operating conditions after the trial burn and prior to any final modifications of the operating conditions in the long-term portion of the permit to reflect the results of the trial burn.]

[Note: The Permit Writer should refer to the RCRA Permit Quality Protocol for additional guidance in developing or reviewing permit conditions. See discussion of the RCRA Permit Quality Protocol in the Introduction to this Model Permit.]

IX(B).A. MODULE HIGHLIGHTS

[The Permit Writer should include a general discussion of the activities covered by this module. The discussion may include some or all of the following information: type of incineration system; types of air pollution control equipment used; system capacity in terms of either heat rate or mass flow rate; key operating conditions, such as combustion temperature (and whether these conditions were based on trial burn results, or data in lieu of a trial burn); a general description of the automatic waste feed cut-off system; the types of waste that may be burned; the principal organic hazardous constituents selected and the rationale for this selection; any unique or special features associated with the operation; and a reference to any special permit conditions.]

IX(B).B. SHAKEDOWN PHASE

During the shakedown phase (the period beginning with the initial introduction of hazardous wastes into the incinerator and ending with the start of the trial burn) the Permittee shall comply with the following conditions:

IX(B).B.1. DURATION OF THE SHAKEDOWN PHASE

The shakedown phase shall not exceed ___ hours of operation when burning hazardous wastes. [40 CFR 264.344(c)(1)]

[Note: The duration of the first shakedown phase cannot exceed 720 hours. The Permittee may petition the Agency for one extension of the shakedown phase for up to 720 additional hours. The Agency may grant the extension when good cause is demonstrated in the petition. The Permit Writer should modify the Permit as necessary to reflect the extension. The modifications may be considered minor modifications. The Permit Writer's justification for granting an extension should be included in the Administrative Record for this Permit.] [40 CFR 264.344(c)(1) and 40 CFR 270.62(a)]

IX(B).B.2. ALLOWABLE WASTE FEED

During the shakedown phase, the Permittee may feed only the following wastes to the incinerator, at the following feed rates, and subject to the requirements of Permit Conditions IX(B).B.3.

[Note: The Permit Writer should identify which waste feeds the Permittee is allowed to incinerate during the shakedown phase and specify their respective feed rates. Any limitations to these waste feeds should also be specified. In some cases, an incinerator may accept only wastes that are always chemically and physically uniform. Identification may then simply be the process name of the waste or some other equivalent identifier. Other facilities may accept waste feeds whose chemical and physical properties vary. Any limitations, and the allowable range of variations for these waste feeds should be specified. Determining these conditions must be based on the Permit Writer's judgment that the facility will meet the performance standards of 40 CFR 264.343. The Permit Writer may choose to limit the waste feed to easily incinerable materials during this period, or to limit the amount of harder to incinerate waste that can be burned during this period. The options presented in Permit Condition IX(A).B. of the module for long-term incineration [Module IX(A)] should be considered by the Permit Writer.]

IX(B).B.3. INSTRUMENTATION AND OPERATIONAL PERFORMANCE REQUIREMENTS

[Note: For each of the waste feed streams specified in Permit Condition IX(B).B.2., the Permit Writer must establish operating conditions that, in the Permit Writer's judgment, ensure compliance with the performance standards of 40 CFR 264.343.]

[Note: 40 CFR 264.345(b)(1)-(4) requires the Permit Writer to establish operating limits for carbon monoxide, waste-feed rate, combustion temperature, and a combustion gas velocity indicator. Permit Conditions IX(B).B.2. and IX(B).B.3.a. through IX(B).B.3.c. cover those requirements. 40 CFR 264.345(b)(6) requires the Permit Writer to establish any other operating requirements (conditions) necessary to ensure compliance with the performance standards. Permit Conditions IX(B).B.3.d. through IX(B).B.3.n. are example permit conditions that serve this purpose. These permit conditions incorporate the list of key operating parameters provided by the EPA Guidance on Trial Burn Reporting and Setting Permit Conditions. This guidance should be consulted for assistance in determining which of these conditions apply for a specific facility and the specific method of setting each condition, given the design and operation of the facility or from data submitted in lieu of a trial burn.]

During the shakedown phase, the Permittee shall feed the wastes described in Permit Condition IX(B).B.2. to the incinerator only under the following conditions:

IX(B).B.3.a. Carbon monoxide concentration in the stack exhaust gas, monitored as specified in Permit Condition IX(B).B.5., and corrected for the amount of oxygen in the stack gas, shall not exceed ____ ppm over a one hour rolling average **[or under the alternative format for CO limits, ___ ppm at any time, or ___ ppm for more than ____ minutes in any clock hour]**.

IX(B).B.3.b. Combustion temperature, monitored as specified in Permit Condition IX(B).B.5., shall be maintained at ___ °F (or °C) or greater.

[Note: For dual-chamber incinerators, *minimum* temperature should be set for each chamber.]

IX(B).B.3.c. Combustion gas velocity, monitored as specified in Permit Condition IX(B).B.5., shall be no greater than ___ ft/s.

IX(B).B.3.d. Atomization fluid pressure (e.g., steam, air) shall be no less than _____ psig.

IX(B).B.3.e. The turndown ratio for the waste burner shall be no greater than _____.

[Note: Permit Conditions IX(B).B.3.f. through IX(B).B.3.h. relate to ensuring compliance with the HCl emission standard in 40 CFR 264.343(b). The Permit Writer must determine which conditions are appropriate for a specific facility depending on the control devices present.]

IX(B).B.3.f. The $\frac{L}{G}$ ratio to the absorber, monitored as specified in Permit Condition IX(B).B.5., shall be maintained at no less than ___ **[sometimes expressed as gals per thousand cubic feet though usually dimensionless]**.

IX(B).B.3.g. The scrubber effluent pH, monitored as specified in Permit Condition IX(B).B.5., shall be maintained at a minimum pH of ___.

IX(B).B.3.h. The scrubber water delivery (nozzle) pressure, monitored as specified in Permit Condition IX(B).B.5., shall be maintained at no less than ___ psig.

[Note: Permit Conditions IX(B).B.3.i. through IX(B).B.3.n. relate to ensuring compliance with the particulate emission standard in 40 CFR 264.343(c). Note, however, that most facilities will not have all of the devices mentioned. The Permit Writer must determine which conditions are appropriate for a specific facility.]

IX(B).B.3.i. Pressure drop across the venturi scrubber, monitored as specified in Permit Condition IX(B).B.5., shall be maintained at no less than ___ psi.

IX(B).B.3.j. The scrubber blowdown rate shall be maintained at no less than _____ gpm.

IX(B).B.3.k. The power to the electrostatic precipitator, monitored as specified in Permit Condition IX(B).B.5., shall be maintained at no less than ___ kVA.

IX(B).B.3.l. The voltage applied to the ionizing wet scrubber, monitored as specified in Permit Condition IX(B).B.5., shall be no less than _____ kV.

IX(B).B.3.m. Pressure drop across the baghouse, monitored as specified in Permit Condition IX(B).B.5., shall be no less than ___ psi, nor greater than ____ psi.

[Note: The Permit Writer may require the Permittee to specify in the Contingency Plan, provisions for maintaining and replacing bags.]

IX(B).B.3.n. The Permittee shall control fugitive emissions from the combustion zone of the incinerator by maintaining the pressure in the primary combustion chamber, monitored as specified in Permit Condition IX(B).B.5., to not exceed _____ inches of mercury. [40 CFR 264.345(d)]

[Note: The Permit Writer may specify another method for controlling fugitive emissions. The method must be demonstrated in the Part B Permit Application; this information should be attached to the Permit, Permit Attachment IX(B)-1, and referenced.]

IX(B).B.3.o. Compliance with the operating conditions specified in Permit Conditions IX(B).B.3.a. through IX(B).B.3.n. will be regarded as compliance with the required performance standards 40 CFR 264.343. However, evidence that compliance with these operating conditions is insufficient to ensure compliance with the performance standards, may justify modification, revocation, or reissuance of the Permit pursuant to 40 CFR 270.41. [40 CFR 264.343(d)]

[Note: It must be understood, by both the Permit Writer and Permittee, that violation of the permit operating conditions can give rise to an enforcement action. If the Permittee complies with the permit operating conditions, but it is later shown that the performance standards are not being achieved, the permit may be modified or revoke and reissued, but enforcement actions are not available. Thus, each set of operating conditions should directly relate to achieving the performance standards in 40 CFR 264.343.]

IX(B).B.4. INSPECTION REQUIREMENTS

The Permittee shall inspect the incineration unit in accordance with the Inspection Schedule, Permit Attachment II-3, and shall complete the following as part of these inspections:

IX(B).B.4.a. The Permittee shall thoroughly, visually inspect the incinerator and associated equipment (including pumps, valves, conveyors, pipes, etc.) for leaks, spills, fugitive emissions, and signs of tampering. [40 CFR 264.347(b)]

IX(B).B.4.b. The Permittee shall thoroughly, visually inspect the instrumentation for out-of-tolerance monitored and/or recorded operational data.

IX(B).B.4.c. The Permittee shall test the emergency waste feed cut-off system and associated alarm at least weekly to verify operability, as specified in Permit Condition IX(B).B.5. [40 CFR 264.347(c)]

[Note: If the Permit ae demonstrates to the Regional Administrator that th weekly inspections referred to in Permit Condition X(B).B.4.c. will unduly restrict or upset operations and that less frequent inspection will be adequate, ie Permit Writer should specify that inspection fr quency in the permit condition. At a minimum, ope ational testing must be conducted at least monthly

IX(B).B.5. MONITORING REQUIREME IS

IX(B).B.5.a. The Permittee shall maintain, calibrate, and operate monitoring e uipment and record the data while incineratin hazardous waste, as specified below:

System Parameter	Monitor Type, Instr. No.	Location	Recording Process	Calibration Frequency
Examples (1) Combustion temperature	Type K Thermo- coup s TIC- 00	[Use design drawing numbers to show the location]	[Indicate whether continuous or not]	[Frequency at which the unit is calibrated
(2) Pressure drop across scrubber venturi	Pressure Se sor PLIC- 1 20			

[Note: At a minim m, this condition must specify monitoring systems that meet the requireme its of 40 CFR 264.347(a)(1) and (2). Permit Condition IX(B).B.5.a. cont ins example specifications for various operating parameters that ust be monitored. Specific parameters should be addressed in the above table. If the Part B Permit Application contains the above infor ation on monitoring practices, in a conveniently organized way d adequately detailed, then the Permit Writer may attach this informati n, Permit Attachment IX(B)-2, to the Permit instead of using a table in this permit module, and reference the attachment.]

IX(B).B 5.b. Upon request of the Agency, the Permittee shall perform sampling and analysis of the waste and exhaust emissions to verify that the operating requirements established in the Permit achieve the performance standards. [40 CFR 264.347(a)(3)]

IX(B).B.6. WASTE FEED CUT-OFF REQUIREMENTS

IX(B).B.6.a. The Permittee shall construct and maintain the systems specified below to automatically cut off the hazardous waste feed to the incinerator at the levels specified below. Hazardous wastes shall be fed to the incinerator only when all instruments required by this condition are on line and operating properly.

Parameter	Cut-Off Limits	Test Frequency
Operating parameters to be interlocked to automatic waste-feed cut off i.e., SCC temperature]	[Level at which waste feed will be cut off]	[Frequency at which operational readiness is checked]

[Note: 40 CFR 264.345(e) requires such systems to be constructed to ensure that the operating conditions specified in the Permit are not exceeded. Most cut-off systems are composed of multiple parameters. They include monitors for the operating conditions presented in Permit Condition IX(B).B.3. along with power failure and flame-out. If the Part B Permit Application adequately provides the above information regarding the automatic waste-feed cut-off system in an organized way and adequately detailed, then the Permit Writer may attach this information, Permit Attachment IX(B)-3, to the Permit, in lieu of using a table in this permit module, and reference the attachment.]

IX(B).B.6.b. In case of a malfunction of the automatic waste feed cut-off systems, the Permittee shall perform manual shut downs in accordance with the approved procedures in Permit Attachment IX(B)-4. The Permittee shall not restart the incinerator until the problem causing the malfunction has been located and corrected.

IX(B).B.7. RECORDKEEPING

IX(B).B.7.a. The Permittee shall record and maintain, in the operating record for this permit, all monitoring and inspection data compiled under the requirements of this Permit (see Permit Condition I.E.9.b.). [40 CFR 264.73 and 40 CFR 264.347(d)]

IX(B).B.7.b. The Permittee shall record in the operating record for this permit the date and time of all automatic waste feed shut-offs, including the triggering parameters, reason for the shut-off, and corrective actions taken. The Permittee shall also record all failures of the automatic waste feed shut-offs to function properly and corrective actions taken.

IX(B).B.8. COMPLIANCE SCHEDULE

[Note: The Permit Writer should include this condition if the Permittee is required to complete specific steps within a specific time period, beyond those covered by other conditions of the Permit, as a criteria for retaining this operating Permit. Compliance schedules are generally used in cases where requirements that are supposed to be met by the Permittee, before the Permit is issued, are deferred for good cause until after permit issuance. Compliance schedules included in the Part B Permit Application should be attached to the Permit. If the application does not include a compliance schedule, the Permit Writer should prepare one and attach it to the Permit. Each compliance schedule should have at least two columns - one identifying the activity and one identifying the milestone or completion dates. The following is an example of a condition that may apply for incineration units.]

The Permittee shall provide the following information to the Regional Administrator:

Item	Date Due to the Regional Administrator
[Example:	
1. Documentation that thermocouple No. TC 2 was installed as shown on Drawing No. 960, dated March 18, 1987	**May 12, 1989**
2. As-built construction drawings for installation of Pressure Sensor No. PS 4	**February 13, 1989]**

IX(B).C. TRIAL BURN PHASE

IX(B).C.1. CONFORMITY TO TRIAL BURN PLAN

The Permittee shall operate and monitor the incinerator during the trial burn phase as specified in the Trial Burn Plan, Permit Attachment IX(B)-5. The Trial Burn Plan shall be revised and resubmitted by the Permittee six (6) months prior to conducting the trial burn or a performance test required under Permit Condition IX(A).E.2. of this permit. The revised Trial Burn Plan must include all applicable EPA-approved test methods and procedures in effect at the time of the resubmittal.

[Note: The Trial Burn Plan must meet the requirements of 40 CFR 270.62(b)(2). The operating and monitoring requirements specified in the plan must be adequate to meet the requirements of 40 CFR 270.62(b)(2)(v). Additional conditions should be established, if necessary, to establish operating conditions which will ensure compliance with the performance standards of 40 CFR 264.343.]

IX(B).C.2. TRIAL POHCs

The principal organic hazardous constituents (POHCs) for which DREs must be determined are:

Waste Feed	POHC(s)
____________________	________________
____________________	________________
____________________	________________
____________________	________________
____________________	________________

[Note: If the Permittee or Permit Writer wishes to establish different operating conditions for various hazardous waste feeds, then POHCs must be selected for each feed or feed group. For example, a facility may wish to designate two (2) waste feeds. Number one waste feed may be a combination of several waste streams that is relatively "easy" to burn based on its POHCs. Number two feed may consist of several waste streams that are "difficult" to burn based on their POHCs. The incinerator operating conditions for these two feeds may be different.]

[Note: Before selecting POHCs for the trial burn, the Permit Writer should review the EPA "Guidance Manual for Hazardous Waste Incinerator Permits" (SW-966), Guidance on Trial Burn Reporting and Setting Permit Conditions, and other appropriate guidances.]

IX(B).C.3. TRIAL BURN DETERMINATIONS

During the trial burn (or as soon after the trial burn as practicable), the Permittee shall make the determinations required by 40 CFR 270.62(b)(6)(i)-(ix).

[Note: Any other determinations that the Permit Writer finds will be needed to ensure that the trial burn will determine compliance with the performance standards should be described as required by 40 CFR 270.62(b)(6)(x).]

IX(B).C.4. TRIAL BURN DATA SUBMISSIONS AND CERTIFICATIONS

The Permittee shall submit a copy of all data collected during the trial burn to the Regional Administrator upon completion of the burn. The Permittee shall submit to the Regional Administrator the results of the determinations required by Condition IX(B).C.3 within ninety (90) days of the completion of the trial burn. All submissions must be certified in accordance with 40 CFR 270.11. [40 CFR 270.62(b)(7) and (9)]

[Note: The Regional Administrator may approve longer time periods for trial burn data submittal for good cause.] [40 CFR 270.62(b)(7)]

IX(B).D. POST-TRIAL BURN PHASE

During the post-trial burn phase (the period starting immediately following the completion of the trial burn and ending when the final operating permit is effective), and for the minimum period sufficient for the Permittee to analyze samples, compute data, and submit trial burn results, and for the Agency to review the trial burn results and make any modifications necessary to the Permit, the Permittee shall comply with the following conditions.

IX(B).D.1. ALLOWABLE WASTE FEED

During the shakedown phase, the Permittee may feed only the following wastes to the incinerator, at the following feed rates, and subject to the requirements of Permit Conditions IX(B).D.2.:

[Note: The Permit Writer should identify which waste feeds the Permittee is allowed to incinerate during the shakedown phase and specify their respective feed rates. Any limitations to these waste feeds should also be specified. In some cases, an incinerator may accept only wastes that are always chemically and physically uniform. Identification may then simply be the process name of the waste or some other equivalent identifier. Other facilities may accept waste feeds whose chemical and physical properties vary. Any limitations, and the allowable range of variations for these waste feeds should be specified. Determining these conditions must be based on the Permit Writer's judgment that the facility will meet the performance standards of 40 CFR 264.343. The Permit Writer may choose to limit the waste feed to easily incinerable materials during this period, or to limit the amount of harder to incinerate waste that can be burned during this period. The options presented in Permit Condition IX(A).B. of the module for long-term incineration [Module IX(A)] should be considered by the Permit Writer.]

IX(B).D.2. INSTRUMENTATION AND OPERATIONAL PERFORMANCE REQUIREMENTS

[Note: For each of the waste feed streams specified in Permit Condition IX(B).D.1., the Permit Writer must establish operating conditions that, in the Permit Writer's judgment, ensure compliance with the performance standards of 40 CFR 264.343.]

[Note: 40 CFR 264.345(b)(1)-(4) requires the Permit Writer to establish operating limits for carbon monoxide, waste-feed rate, combustion temperature, and a combustion gas velocity indicator. Permit Conditions IX(B).D.1. and IX(B).D.2.a. through IX(B).D.2.c. cover those requirements. 40 CFR 264.345(b)(6) requires the Permit Writer to establish any other operating requirements (conditions) necessary to ensure compliance with the performance standards. Permit Conditions IX(B).D.2.d. through IX(B).D.2.n. are example permit conditions that serve this purpose. These permit conditions incorporate the list of key operating parameters provided by the EPA Guidance on Trial Burn Reporting and Setting Permit Conditions. This guidance should be consulted for assistance in determining which of these conditions apply for a specific facility and the specific method of setting each condition, given the design and operation of the facility and the results of the trial burn or from data submitted in lieu of a trial burn.]

During the shakedown phase, the Permittee shall feed the wastes described in Permit Condition IX(B).D.1. to the incinerator only under the following conditions:

IX(B).D.2.a. Carbon monoxide concentration in the stack exhaust gas, monitored as specified in Permit Condition IX(B).D.4., and corrected for the amount of oxygen in the stack gas, shall not exceed ____ ppm over a one hour rolling average **[or under the alternative format for CO limits, ___ ppm at any time, or ___ ppm for more than ____ minutes in any clock hour]**.

IX(B).D.2.b. Combustion temperature, monitored as specified in Permit Condition IX(B).D.4., shall be maintained at ___ °F (or °C) or greater.

[Note: For dual-chamber incinerators, minimum temperature should be set for each chamber.]

IX(B).D.2.c. Combustion gas velocity, monitored as specified in Permit Condition IX(B).D.4., shall be no greater than ___ ft/s.

IX(B).D.2.d. Atomization fluid pressure (e.g., steam, air) shall be no less than _____ psig.

IX(B).D.2.e. The turndown ratio for the waste burner shall be no greater than _____.

[Note: Permit Conditions IX(B).D.2.f. through IX(B).D.2.h. relate to ensuring compliance with the HCl emission standard in 40 CFR 264.343(b). The Permit Writer must determine which conditions are appropriate for a specific facility depending on the control devices present.]

IX(B).D.2.f. The $\frac{L}{G}$ ratio to the absorber, monitored as specified in Permit Condition IX(B).D.4., shall be maintained at no less than ___ **[sometimes expressed as gals per thousand cubic feet though usually dimensionless]**.

IX(B).D.2.g. The scrubber effluent pH, monitored as specified in Permit Condition IX(B).D.4., shall be maintained at a minimum pH of ___.

IX(B).D.2.h. The scrubber water delivery (nozzle) pressure, monitored as specified in Permit Condition IX(B).D.4., shall be maintained at no less than ___ psig.

[Note: Permit Conditions IX(B).D.2.i. through IX(B).D.2.n. relate to ensuring compliance with the particulate emission standard in 40 CFR 264.343(c). Note, however, that most facilities will not have all of the devices mentioned. The Permit Writer must determine which conditions are appropriate for a specific facility.]

IX(B).D.2.i. Pressure drop across the venturi scrubber, monitored as specified in Permit Condition IX(B).D.4., shall be maintained at no less than ___ psi.

IX(B).D.2.j. The scrubber blowdown rate shall be maintained at no less than _____ gpm.

IX(B).D.2.k. The power to the electrostatic precipitator, monitored as specified in Permit Condition IX(B).D.4., shall be maintained at no less than ___ kVA.

IX(B).D.2.l. The voltage applied to the ionizing wet scrubber, monitored as specified in Permit Condition IX(B).D.4., shall be no less than _____ kV.

IX(B).D.2.m. Pressure drop across the baghouse, monitored as specified in Permit Condition IX(B).D.4., shall be no less than ___ psi, nor greater than ____ psi.

[Note: The Permit Writer may require the Permittee to specify in the Contingency Plan, provisions for maintaining and replacing bags.]

IX(B).D.2.n. The Permittee shall control fugitive emissions from the combustion zone of the incinerator by maintaining the pressure in the primary combustion chamber, monitored as specified in Permit Condition IX(B).D.4., to not exceed _____ inches of mercury. [40 CFR 264.345(d)]

[Note: The Permit Writer may specify another method for controlling fugitive emissions. The method must be demonstrated in the Part B Permit Application; this information should be attached to the Permit, Permit Attachment IX(B)-1, and referenced.]

IX(B).D.2.o. Compliance with the operating conditions specified in Permit Conditions IX(B).D.2.a. through IX(B).D.2.n. will be regarded as compliance with the required performance standards 40 CFR 264.343. However, evidence that compliance with these operating conditions is insufficient to ensure compliance with the performance standards, may justify modification, revocation, or reissuance of the Permit pursuant to 40 CFR 270.41. [40 CFR 264.343(d)]

[Note: It must be understood, by both the Permit Writer and Permittee, that violation of the permit operating conditions can give rise to an enforcement action. If the Permittee complies with the permit operating conditions, but it is later shown that the performance standards are not being achieved, the permit may be modified or revoke and reissued, but enforcement actions are not available. Thus, each set of operating conditions should directly relate to achieving the performance standards in 40 CFR 264.343.]

IX(B).D.3. INSPECTION REQUIREMENTS

The Permittee shall inspect the incineration unit in accordance with the Inspection Schedule, Permit Attachment II-3, and shall complete the following as part of these inspections:

IX(B).D.3.a. The Permittee shall thoroughly, visually inspect the incinerator and associated equipment (including pumps, valves, conveyors, pipes, etc.) for leaks, spills, fugitive emissions, and signs of tampering. [40 CFR 264.347(b)]

IX(B).D.3.b. The Permittee shall thoroughly, visually inspect the instrumentation for out-of-tolerance monitored and/or recorded operational data.

IX(B).D.3.c. The Permittee shall test the emergency waste feed cut-off system and associated alarm at least weekly to verify operability, as specified in Permit Condition IX(B).D.4. [40 CFR 264.347(c)]

[Note: If the Permittee demonstrates to the Regional Administrator that the weekly inspections referred to in Permit Condition IX(B).D.3.c. will unduly restrict or upset operations and that less frequent inspection will be adequate, the Permit Writer should specify that inspection frequency in the permit condition. At a minimum, operational testing must be conducted at least monthly.]

IX(B).D.4. MONITORING REQUIREMENTS

IX(B).D.4.a. The Permittee shall maintain, calibrate, and operate monitoring equipment and record the data while incinerating hazardous waste, as specified below:

System Parameter	Monitor Type, Instr. No.	Location	Recording Process	Calibration Frequency
Examples (1) Combustion temperature	Type K Thermocouple TIC-900	[Use design drawing numbers to show the location]	[Indicate whether continuous or not]	[Frequency at which the unit is calibrated
(2) Pressure drop across scrubber venturi	Pressure Sensor PDIC-1220			

[Note: At a minimum, this condition must specify monitoring systems that meet the requirements of 40 CFR 264.347(a)(1) and (2). Permit Condition IX(B).D.4.a. contains example specifications for various operating parameters that must be monitored. Specific parameters should be addressed in the above table. If the Part B Permit Application contains the above information on monitoring practices, in a conveniently

Item	Date Due to the Regional Administrator
[**Example:**	
1. **Documentation that thermocouple No. TC 2 was installed as shown on Drawing No. 960, dated March 18, 1987**	**May 12, 1989**
2. **As-built construction drawings for installation of Pressure Sensor No. PS 4**	**February 13, 1989**]

IX(B).E. REPORTING NON-COMPLIANCE DURING THE TRIAL BURN

If based upon the analytical results of the trial burn and before submitting the required trial burn results, the Permittee determines that the incinerator failed to achieve any of the performance standards specified in 40 CFR 264.343, the Permittee shall notify the Regional Administrator within twenty-four (24) hours of making the determination. Upon the request of the Regional Administrator, the Permittee shall cease feeding hazardous waste to the incinerator. The Permittee may apply to the Regional Administrator for a permit modification pursuant to 40 CFR 270.41 and for a new trial burn pursuant to 40 CFR 270.62(b).

PERMIT ATTACHMENTS REFERENCED IN MODULE IX(B) - SHORT-TERM TEST INCINERATION

This list is provided to assist the Permit Writer in checking that all Permit Attachments referenced in this module are attached to the Permit. The purpose of the numbering scheme used here is to facilitate cross-walking with the model permit conditions. The Permit Writer may select other numbering schemes, as appropriate, when preparing actual Permits.

Permit Attachment No.	Plan or Document (from the Part B Permit Application)
II-3	Facility Inspection Schedule
IX(B)-1	Description of Procedures for Controlling Fugitive Emissions
IX(B)-2	Description of Monitoring Systems
IX(B)-3	Description of Automatic Waste Feed Cut-Off Systems
IX(B)-4	Description of Manual Waste Feed Cut-Off Systems
IX(B)-5	Trial Burn Plan

APPENDIX D

REFERENCES AND GUIDANCE DOCUMENTS FOR HAZARDOUS WASTE INCINERATORS

References and Guidance Documents for Hazardous Waste Incinerators

1. "Guidance Manual for Hazardous Waste Incinerator Permits," USEPA, PB84-100577, July 1983.

2. "Sampling and Analysis Methods for Hazardous Waste Combustion," A Report Prepared by A. D. Little, Inc. for USEPA, PB84-155845, February 1984.

3. "Permit Writers Guide to Test Burn Data--Hazardous Waste Incineration," USEPA, EPA/625/6-86/012, September 1986.

4. "Practical Guide--Trial Burns for Hazardous Waste Incinerators," A Report Prepared by Midwest Research Institute for EPA, PB86-190246, April 1986.

5. "Guidance on PIC Controls for Hazardous Waste Incineration," MRI, Draft, 1989.

6. "Hazardous Waste Incineration Measurement Guidance Manual," MRI, Draft, 1988.

7. "Guidance on Metals and Hydrogen Chloride for Hazardous Waste Incinerators," Versar, Draft, 1989.

8. "Trial Burn Observation Guide," Prepared by Midwest Research Institute for EPA, 1988.

9. "Guidance on Setting Permit Conditions and Reporting Trial Burn Results," Acurex/EER/MRI, 1989.

10. Engineering Handbook for Hazardous Waste Incineration, U.S. EPA, SW-889, September 1981.

APPENDIX E

HEAT OF COMBUSTION INCINERABILITY RANKING

TABLE 2-4

RANKING OF INCINERABILITY OF ORGANIC HAZARDOUS CONSTITUENTS FROM APPENDIX VIII, PART 261 ON THE BASIS OF HEAT OF COMBUSTION

Hazardous Constituent	Heat of Combustion kcal/gram	Hazardous Constituent	Heat of Combustion kcal/gram
Trichloromonofluoromethane	0.11	Bis(chloromethyl)ether	1.97
Tribromomethane	0.13	1,1,1-Trichloroethane	1.99
Dichlorodifluoromethane	0.22	1,1,2-Trichloroethane	1.99
Tetrachloromethane (Carbon Tetrachloride)	0.24	Pentachlorobenzene	2.05
Tetranitromethane	0.41	Pentachlorophenol	2.09
Hexachloroethane	0.46	Hexachlorocyclopentadiene	2.10
Dibromomethane	0.50	Hexachlorobutadiene	2.12
Pentachloroethane	0.53	Kepone	2.15
Hexachloropropene	0.70	2,3,4,6-Tetrachlorophenol	2.23
Chloroform	0.75	Dichlorophenylarsine	2.31
Chloral(trichloroacetaldehyde)	0.80	Decachlorobiphenyl	2.31
Cyanogen bromide	0.81	Endosulfan	2.33
Trichloromethanethiol	0.84	Nonachlorobiphenyl	2.50
Hexachlorocyclohexane	1.12	Toxaphene	2.50
Tetrachloroethene (Tetrachloroethylene)	1.19	1,2,4,5-Tetrachlorobenzene	2.61
Cyanogen chloride	1.29	Bromoacetone	2.66
Formic acid	1.32	Dichloroethylene, N.O.S.	2.70
Iodomethane	1.34	1,1-Dichloroethylene	2.70
Tetrachloroethane, N.O.S.	1.39	Chlordane	2.71
1,1,1,2-Tetrachloroethane	1.39	Heptachlor epoxide	2.71
1,1,2,2-Tetrachloroethane	1.39	Phenylmercury acetate	2.71
1,2-Dibromoethane	1.43	Octachlorobiphenyl	2.72
1,2-Dibromo-3-chloropropane	1.48	Acetyl chloride	2.77
Pentachloronitrobenzene	1.62	Trichloropropane, N.O.S.	2.81
Bromomethane	1.70	1,2,3-Trichloropropane	2.81
Dichloromethane	1.70	Dichloropropanol, N.O.S.	2.84
Trichloroethene (Trichloroethylene)	1.74	Dimethyl sulfate	2.86
Hexachlorobenzene	1.79	2,4,5-T	2.87

TABLE 2-4 (Continued)

Hazardous Constituent	Heat of Combustion kcal/gram	Hazardous Constituent	Heat of Combustion kcal/gram
2,4,5-Trichlorophenol	2.88	Pentachlorobiphenyl	3.66
2,4,6-Trichlorophenol	2.88	1,3-Propane sultone	3.67
N-Nitroso-N-methylurea	2.89	Methyl methanesulfonate	3.74
Heptachlorobiphenyl	2.98	Aldrin	3.75
1,1-Dichloroethane	3.00	Nitroglycerine	3.79
1,2-Dichloroethane	3.00	2,4-Dichlorophenol	3.81
trans-1,2-Dichloroethane	3.00	2,6-Dichlorophenol	3.81
Phenyl dichloroarsine	3.12	Hexachlorophene	3.82
N-Nitrososarcosine	3.19	Trypan blue	3.84
Azaserine	3.21	Benzotrichloride	3.90
2-Fluoroacetamide	3.24	Cycasin	3.92
Chloromethane	3.25	N-Nitroso-N-ethylurea	3.92
Hexachlorobiphenyl	3.28	Cyclophosphamide	3.97
Bis (2-chloroethyl) ether	3.38	Dichloropropane, N.O.S.	3.99
1,2,3,4,10,10-Hexachloro-1,4,4a,5,7,8a-hexahydro-1,4:5,8-endo, endo-dimethanonaphthalene	3.38	1,2-Dichloropropane	3.99
		Methylparathion	4.00
Benzenearsonic acid	3.40	Uracil mustard	4.00
Maleic anhydride	3.40	Amitrole	4.01
1,2,4-Trichlorobenzene	3.40	Dimethoate	4.02
TCDD	3.43	Tetraethyl lead	4.04
Dichloropropene, N.O.S.	3.44	4,6-Dinitro-o-cresol and salts	4.06
1,3-Dichloropropene	3.44	N-Methyl-N -nitro-N-nitrosoguanidine	4.06
Endrin	3.46	Mustard gas	4.06
Chloromethyl methyl ether	3.48	Maleic hydrazide	4.10
2,4-Dinitrophenol	3.52	Dinitrobenzene, N.O.S.	4.15
Nitrogen mustard N-oxide and hydrochloride salt	3.56	N-Nitroso-N-methylurethane	4.18
		1,4-Dichloro-2-butene	4.27
Parathion	3.61	Nitrogen mustard and hydrochloride salt	4.28
2,4-D	3.62	Tetrachlorobiphenyl	4.29

TABLE 2-4 (Continued)

Hazardous Constituent	Heat of Combustion kcal/gram	Hazardous Constituent	Heat of Combustion kcal/gram
Hydrazine	4.44	Phthalic anhydride	5.29
Vinyl chloride	4.45	1-(o-chlorophenyl) thiourea	5.30
Formaldehyde	4.47	2-Methyl-2-(methylthio) propionaldehyde-o-(methylcarbonyl) oxime	5.34
Saccharin	4.49	2-sec-Butyl-4,6 dinitrophenol (DNBP)	5.46
3-Chloropropionitrile	4.50	p-Nitroaniline	5.50
DDT	4.51	Chlorobenzilate	5.50
Thiourea	4.51	Dieldrin	5.56
1-Acetyl-2-thiourea	4.55	2,4,5-TP	5.58
Thiosemicarbazide	4.55	Methoxychlor	5.59
Dichlorobenzene, N.O.S.	4.57	4-Nitroquinoline-1-oxide	5.59
Ethyl cyanide	4.57	Diallate	5.62
Bis (2-chloroethoxy) methane	4.60	Daunomycin	5.70
2,4-Dinitrotoluene	4.68	Ethylenebisdithiocarbamate	5.70
Isocyanic acid, methyl ester	4.69	3,3'-Dichlorobenzidine	5.72
7-Oxabicyclo (2.2.1) heptane-2,3-dicarboxylic acid	4.70	Pronamide	5.72
Ethyl carbamate	4.73	Aflatoxins	5.73
5-(Aminomethyl)-3-isoxazolol	4.78	Disulfoton	5.73
Methylthiouracil	4.79	4,6-Dinitrophenol	5.74
4,4'-Methylene-bis-(2-chloroaniline)	4.84	Diepoxybutane	5.74
Bis (2-chloroisopropyl) ether	4.93	Dimethyl phthalate	5.74
4-Nitrophenol	4.95	Glycidylaldehyde	5.74
DDE	5.05	Acrylamide	5.75
Dimethylcarbamoyl chloride	5.08	3,3-Dimethyl-1-(methylthio)-2-butanone-O-(methylamino)carbonyl oxime	5.82
p-Chloro-m-cresol	5.08	4-Bromophenyl phenyl ether	5.84
Dichloromethylbenzene	5.09	Thiuram	5.85
Trichlorobiphenyl	5.10	Methanethiol	5.91
DDD	5.14	Tolylene diisocyanate	5.92
Dimethylnitrosoamine	5.14	Chlorambucil	5.93
N-Nitrosodimethylamine	5.14	Thioacetamide	5.95
Diethylarsine	5.25		

TABLE 2-4 (Continued)

Hazardous Constituent	Heat of Combustion kcal/gram	Hazardous Constituent	Heat of Combustion kcal/gram
Ethylenethiourea	5.98	2-Butanone peroxide	6.96
Malononitrile	5.98	p-Dimethylaminoazobenzene	6.97
5-Nitro-o-toluidine	5.98	1,4-Naphthoquinone	6.97
Nitrobenzene	6.01	3-(alpha-Acetonylbenzyl)-4-hydroxycoumarin and salts (Warfarin)	7.00
3,4-Dihydroxy-alpha-(methylamino)methyl benzyl alcohol	6.05	N-Nitrosodiethanolamine	7.02
Benzoquinone	6.07	N-Nitrosopiperidine	7.04
N-Nitrosomethylethylamine	6.13	N-Nitrosonornicotine	7.07
p-Chloroaniline	6.14	Phenacetin	7.17
Benzyl chloride	6.18	Ethyl methacrylate	7.27
Resorcinol	6.19	Di-n-butyl phthalate	7.34
Propylthiouracil	6.28	3,3'-Dimethoxybenzidine	7.36
Paraldehyde	6.30	Acetonitrile	7.37
Dichlorobiphenyl	6.36	4-Aminopyridine	7.37
Diethyl phthalate	6.39	2-Chloronaphthalene	7.37
Dioxane	6.41	2 Propyn-1-ol	7.43
2-Methyllactonitrile	6.43	1-Naphthyl-2-thiourea	7.50
N-Nitrosopyrrolidone	6.43	Isosafrole	7.62
Methyl methacrylate	6.52	Dihydrosafrole	7.66
Chlorobenzene	6.60	Safrole	7.68
o-Toluidine hydrochloride	6.63	Auramine	7.69
N,N-Bis (2-chloroethyl)-2-naphthylamine	6.64	Crotonaldehyde	7.73
2,6-Dinitrotoluene di-n-octyl phthalate	6.67	Allyl alcohol	7.75
Reserpine	6.70	Monochlorobiphenyl	7.75
Methyl hydrazine	6.78	Phenol	7.78
Cyanogen	6.79	Phenylenediamine	7.81
Ethylene oxide	6.86	Di-n-propylnitrosoamine	7.83
N-Nitrosodiethylamine	6.86	Pyridine	7.83
2-Chlorophenol	6.89	Ethyleneimine	7.86
N-Phenylthiourea	6.93	1,1-Dimethylhydrazine	7.87
Acrolein	6.96	1,2-Dimethylhydrazine	7.87

TABLE 2-4 (Continued)

Hazardous Constituent	Heat of Combustion kcal/gram	Hazardous Constituent	Heat of Combustion kcal/gram
N-Nitrosomethylvinylamine	7.91	3,3'-Dimethoxybenzidine	8.81
2-Acetylaminofluorine	7.82	7H-Dibenzo (c,g) carbazole	8.90
Acrylonitrile	7.93	Benz (c) acridine	8.92
Methapyrilene	7.93	Nicotine and salts	8.92
Strychnine and salts	8.03	4-Amino biphenyl	9.00
Methyl ethyl ketone (MEK)	8.07	Diphenylamine	9.09
Cresylic acid	8.09	2-Methylaziridine	9.09
Cresol	8.18	Benzidine	9.18
Toluene diamine	8.24	Benzo (b) fluoranthene	9.25
Acetophenone	8.26	Benzo (j) fluoranthene	9.25
Butyl benzyl phthalate	8.29	Benzo (a) pyrene	9.25
Ethyl cyanide	8.32	Dibenzo (a,e) pyrene	9.33
Bis (2-ethylhexyl) phthalate	8.42	Dibenzo (a,h) pyrene	9.33
Benzenethiol	8.43	Dibenzo (a,i) pyrene	9.33
N-Nitrosodi-N-butylamine	8.46	Fluoranthene	9.35
2,4-Dimethylphenol	8.51	Benz (a) anthracene	9.39
Indenol (1,2,3-c,d) pyrene	8.52	Dibenz (a,h) anthracene (Dibenzo (a,h) anthracene)	9.40
Diethylstilbestrol	8.54	Dibenz (a,h) acridine	9.53
1-Naphthylamine	8.54	Dibenz (a,j) acirdine	9.53
2-Naphthylamine	8.54	alpha, alpha-Dimethylphenethylamine	9.54
Methacrylonitrile	8.55	3-Methylcholanthrene	9.57
Isobutyl alcohol	8.62	n-Propylamine	9.58
1,2-Diethylhydrazine	8.68	7,12-Dimethylbenz (a) anthracene	9.61
2-Picoline	8.72	Naphthalene	9.62
Aniline	8.73	Benzene	10.03
1,2-Diphenylhydrazine	8.73	Toluene	10.14

APPENDIX F

THERMAL STABILITY-BASED INCINERABILITY RANKING

Table D-1. Principal Hazardous Organic Constituent Thermal Stability Index

Principal Hazardous Organic Constituent	Rank
CLASS 1	
CYANOGEN {ETHANEDINITRILE}	1
HYDROGEN CYANIDE {HYDROCYANIC ACID} [2]	2
BENZENE [2]	3
SULFUR HEXAFLUORIDE [3]	4
NAPHTHALENE [2]	5
FLUORANTHENE {BENZO[j,k]FLUORENE}	6
BENZO[j]FLUORANTHENE {7,8-BENZOFLUORANTHENE}	7
BENZO[b]FLUORANTHENE {2,3-BENZOFLUORANTHENE}	8
BENZANTHRACENE (1,2-) {BENZ[a]ANTHRACENE}	9
CHRYSENE {1,2-BENZPHENANTHRENE}	10
BENZO[a]PYRENE {1,2-BENZOPYRENE}	11
DIBENZ[a,h]ANTHRACENE {1,2,5,6-DIBENZANTHRACENE}	12
INDENO(1,2,3-cd)PYRENE {1,10-(1,2-PHENYLENE)PYRENE}	13
DIBENZO[a,h]PYRENE {1,2,5,6-DIBENZOPYRENE}	14
DIBENZO[a,i]PYRENE {1,2,7,8-DIBENZOPYRENE}	15
DIBENZO[a,e]PYRENE {1,2,4,5-DIBENZOPYRENE}	16
CYANOGEN CHLORIDE {CHLORINE CYANIDE}	17-18
ACETONITRILE {ETHANENITRILE} [2]	17-18
CHLOROBENZENE [2]	19
ACRYLONITRILE {2-PROPENENITRILE} [2]	20
DICHLOROBENZENE {1,4-DICHLOROBENZENE}	21-22
CHLORONAPHTHALENE (1-) [2]	21-22
CYANOGEN BROMIDE {BROMINE CYANIDE}	23-24
DICHLOROBENZENE {1,2-DICHLOROBENZENE} [2]	23-24
DICHLOROBENZENE {1,3-DICHLOROBENZENE} [2]	25
TRICHLOROBENZENE (1,3,5-TRICHLOROBENZENE) [2] [4]	26-27
TRICHLOROBENZENE (1,2,4-TRICHLOROBENZENE) [2]	26-27
TETRACHLOROBENZENE (1,2,3,5-TETRACHLOROBENZENE) [2] [4]	20
CHLOROMETHANE {METHYL CHLORIDE} [2]	29-30
TETRACHLOROBENZENE (1,2,4,5-TETRACHLOROBENZENE)	29-30
PENTACHLOROBENZENE [2]	31-33
HEXACHLOROBENZENE [2]	31-33
BROMOMETHANE {METHYL BROMIDE} [2]	31-33
TETRACHLORODIBENZO-p-DIOXIN (2,3,7,8-) {TCDD}	34
CLASS 2	
TOLUENE {METHYLBENZENE} [2]	35
TETRACHLOROETHENE [2]	36
CHLOROANILINE {CHLOROBENZENAMINE}	37
DDE{1,1-DICHLORO-2,2-BIS(4-CHLOROPHENYLETHYLENE}	38
FORMIC ACID {METHANOIC ACID}	39-40
PHOSGENE {CARBONYL CHLORIDE}	39-40
TRICHLOROETHENE [2]	41
DIPHENYLAMINE {N-PHENYLBENZENAMINE}	42-44
DICHLOROETHENE (1,1-) [2]	42-44
FLUOROACETIC ACID	42-44
DIMETHYLBENZ[a]ANTHRACENE (7,12-)	45
ANILINE {BENZENAMINE}	46-50
FORMALDEHYDE {METHYLENE OXIDE}	46-50
MALONONITRILE {PROPANEDINITRILE}	46-50
METHYL CHLOROCARBONATE {CARBONOCHLORIDIC ACID, METHYL ESTER}	46-50

Table D-1. Principal Hazardous Organic Constituent Thermal Stability Index (continued)

Principal Hazardous Organic Constituent	Rank
METHYL ISOCYANATE {METHYLCARBYLAMINE}	46-50
AMINOBIPHENYL (4-) {[1,1'-BIPHENYL]-4-AMINE}	51
NAPHTHYLAMINE (1-)	52-53
NAPHTHYLAMINE (2-)	52-53
DICHLOROETHENE (trans-1,2-) [2]	54
FLUOROACETAMIDE (2-)	55-56
PROPYN-1-OL (2-) {PROPARGYL ALCOHOL}	55-56
PHENYLENEDIAMINE (1,4) {BENZENEDIAMINE}	57-59
PHENYLENEDIAMINE (1,2-) {BENZENEDIAMINE}	57-59
PHENYLENEDIAMINE (1,3-) {BENZENEDIAMINE}	57-59
BENZIDINE {[1,1'-BIPHENYL]-4,4'DIAMINE}	60-64
ACRYLAMIDE {2-PROPENAMIDE}	60-64
DIMETHYLPHENETHYLAMINE (alpha, alpha-)	60-64
METHYL METHACRYLATE {2-PROPENOIC ACID, 2-METHYL-, METHYL ESTER}	60-64
VINYL CHLORIDE (CHLOROETHENE)	60-64
DICHLOROMETHANE {METHYLENE CHLORIDE} [2]	65-66
METHACRYLONITRILE {2-METHYL-2-PROPENENITRILE} [2]	65-66
DICHLOROBENZIDINE (3,3'-)	67
METHYLCHOLANTHRENE (3-)	68
TOLUENEDIAMINE (2,6-) {DIAMINOTOLUENE}	69-77
TOLUENEDIAMINE (1,4-) {DIAMINOTOLUENE}	69-77
TOLUENEDIAMINE (2,4-) {DIAMINOTOLUENE}	69-77
TOLUENEDIAMINE (1,3-) {DIAMINOTOLUENE}	69-77
TOLUENEDIAMINE (3,5-) {DIAMINOTOLUENE}	69-77
TOLUENEDIAMINE (3,4-) {DIAMINOTOLUENE}	69-77
CHLORO-1,3-BUTADIENE (2-) {CHLOROPRENE}	69-77
PRONAMIDE {3,5-DICHLORO-N-[1,1-DIMETHYL-2-PROPYNYL] BENZAMIDE}	69-77
ACETYLAMINOFLUORENE (2-) {ACETAMIDE,N-[9H-FLUOREN-2-YL]-}	69-77
<u>CLASS 3</u>	
DIMETHYLBENZIDINE (3,3'-)	78
n-PROPYLAMINE {1-PROPANAMINE}	79
PYRIDINE [2]	80
PICOLINE (2-) {PYRIDINE, 2-METHYL-}	81-84
DICHLOROPROPENE (1,1-) [2]	81-84
THIOACETAMIDE {ETHANETHIOAMIDE}	81-84
1,2,2-TRICHLORO-1,1,2-TRIFLUOROETHANE [2] [3]	81-84
BENZ[c]ACRIDINE {3,4-BENZACRIDINE}	85-88
DICHLORODIFLUOROMETHANE [2]	85-88
ACETOPHENONE {ETHANONE, 1-PHENYL-} [2]	85-88
TRICHLOROFLUOROMETHANE [2]	85-88
DICHLOROPROPENE (trans-1,2-)	89-91
ETHYL CYANIDE {PROPIONITRILE} [2]	89-91
BENZOQUINONE {1,4-CYCLOHEXADIENEDIONE}	89-91
DIBENZ[a,h]ACRIDINE {1,2,5,6-DIBENZACRIDINE}	92-97
DIBENZ[a,j]ACRIDINE {1,2,7,8-DIBENZACRIDINE}	92-97
HEXACHLOROBUTADIENE (trans-1,3) [2]	92-97
NAPHTHOQUINONE (1,4-) {1,4-NAPHTHALENEDIONE}	92-97
DIMETHYL PHTHALATE [2]	92-97
ACETYL CHLORIDE {ETHANOYL CHLORIDE} [2]	92-97
ACETONYLBENZYL-4-HYDROXYCOUMARIN (3-alpha-) {WARFARIN}	98-99
MALEIC ANHYDRIDE {2,5-FURANDIONE}	98-99

Table D-1. Principal Hazardous Organic Constituent Thermal Stability Index (continued)

Principal Hazardous Organic Constituent	Rank
PHENOL {HYDROXYBENZENE}	100-101
DIBENZO[c,g]CARBAZOLE (7H-) {3,4,5,6-DIBENZCARBAZOLE}	100-101
CHLOROPHENOL (2-)	102
CRESOL (1,3-) {METHYLPHENOL}	103
CRESOL (1,4-) {METHYLPHENOL} [2]	104-105
CRESOL (1,2-) {METHYLPHENOL}	104-105
ACROLEIN {2-PROPENAL}	106-107
DIHYDROXY-ALPHA-[METHYLAMINO]METHYL BENZYL ALCOHOL (3,4-)	106-107
METHYL ETHYL KETONE {2-BUTANONE} [2]	108-109
DIETHYLSTILBESTEROL	108-109
BENZENETHIOL {THIOPHENOL} [2]	110
RESORCINOL {1,3-BENZENEDIOL}	111
ISOBUTYL ALCOHOL {2-METHYL-1-PROPANOL} [2]	112
CROTONALDEHYDE {2-BUTENAL} [2]	113-115
DICHLOROPHENOL (2,4-)	113-115
DICHLOROPHENOL (2,6-)	113-115
METHYLACTONITRILE (2-) {PROPANENITRILE,2-HYDROXY-2-METHYL}	116-118
ALLYL ALCOHOL {2-PROPEN-1-OL}	116-118
CHLOROCRESOL {4-CHLORO-3-METHYLPHENOL}	116-118
DIMETHYLPHENOL (2,4-)	119
<u>CLASS 4</u>	
CHLOROPROPENE 3-{ALLYL CHLORIDE} [2]	120
DICHLOROPROPENE (cis-1,3-)	121-125
DICHLOROPROPENE (trans-1,3-)	121-125
TETRACHLOROETHANE (1,1,2,2-) [2]	121-125
TRICHLOROPHENOL (2,4,5-)	121-125
TRICHLOROPHENOL (2,4,6-)	121-125
CHLOROETHANE (ETHYL CHLORIDE) [4] [5]	126
DICHLOROPROPENE (2,3-)	127-130
HYDRAZINE (DIAMINE) [5]	127-130
BENZYL CHLORIDE {CHLOROMETHYLBENZENE} [2]	127-130
DIBROMOMETHANE {METHYLENE BROMIDE} [2]	127-130
DICHLOROETHANE (1,2-) [2]	131
MUSTARD GAS {bis[2-CHLOROETHYL]-SULFIDE}	132-134
NITROGEN MUSTARD	132-134
N,N-BIS(2-CHLOROETHYL)2-NAPHTHYLAMINE {CHLORNAPHAZINE}	132-134
DICHLOROPROPENE (3,3-)	135
DICHLORO-2-BUTENE (1,4-)	136-140
TETRACHLOROPHENOL (2,3,4,6-)	136-140
TETRACHLOROMETHANE {CARBONTETRACHLORIDE} [2]	136-140
BROMOACETONE {1-BROMO-2-PROPANONE}	136-140
HEXACHLOROPHENE {2,2'-METHYLENEbis[3,4,6-TRICHLOROPHENOL]}	136-140
DIOXANE (1,4-) {1,4-DIETHYLENE OXIDE} [2]	141
CHLORAMBUCIL	142
NITROBENZENE [2]	143
CHLOROPROPIONITRILE (3-) {3-CHLOROPROPANENITRILE} [2]	143-144
DICHLORO-2-PROPANOL (1,1-)	145-146
DDD {DICHLORODIPHENYLDICHLOROETHANE}	145-146
DICHLORO-2-PROPANOL (1,3-)	147
PHTHALIC ANHYDRIDE {1,2-BENZENEDICARBOXYLIC ACID ANHYDRIDE}	148-150
METHYL PARATHION	148-150

Table D-1. Principal Hazardous Organic Constituent Thermal Stability Index (continued)

Principal Hazardous Organic Constituent	Rank
NITROPHENOL (4-)	148-150
CHLORODIFLUOROMETHANE [2] [4]	151-153
PENTACHLOROPHENOL -	151-153
HEXACHLOROCYCLOHEXANE {LINDANE} [2]	151-153
DICHLOROFLUOROMETHANE [2] [4]	154-157
DINITROBENZENE (1,3-)	154-157
NITROANILINE {4-NITROBENZENAMINE}	154-157
PENTACHLOROETHANE [2]	154-157
DINITROBENZENE (1,4-)	158-161
DINITROBENZENE (1,2-)	158-161
TRICHLOROETHANE (1,1,2-) [2]	158-161
TRICHLOROMETHANE {CHLOROFORM} [2]	158-161
DIELDRIN	162-164
ISODRIN	162-164
ALDRIN	162-164
DICHLOROPROPANE (1,3-) [5]	165
NITROTOLUIDINE (5-) {BENZENAMINE,2-METHYL-5-NITRO-}	166-167
CHLOROACETALDEHYDE	166-167
TRICHLOROPROPANE (1,2,3-) [2]	168-173
DINITROTOLUENE (2,4-)	168-173
DINITROTOLUENE (2,6-)	168-173
HEXACHLOROCYCLOPENTADIENE	168-173
BENZAL CHLORIDE {ALPHA, ALPHA-DICHLOROTOLUENE} [2]	168-173
DICHLORO-1-PROPANOL (2,3-)	168-173
ETHYLENE OXIDE {OXIRANE} [5]	174
DICHLOROETHANE (1,1-) {ETHYLIDENE DICHLORIDE} [5]	175-178
DIMETHYLCARBAMOYLCHLORIDE	175-178
GLYCIDYALDEHYDE {1-PROPANOL-2,3-EPOXY}	175-178
DDT {DICHLORODIPHENYLTRICHLOROETHANE}	175-178
DICHLOROPROPANE (1,2-) {PROPYLENE DICHLORIDE} [5]	179
AURAMINE	180-181
HEPTACHLOR	180-181
DICHLOROPROPANE (1,1-) [5]	182
CHLORO-2,3-EPOXYPROPANE (1-) {OXIRANE,2-CHLOROMETHYL-}	183-186
DINITROPHENOL (2,4-)	183-186
bis(2-CHLOROETHYL)ETHER [2]	183-186
TRINITROBENZENE {1,3,5-TRINITROBENZENE}	183-186
BUTYL-4,6-DINITROPHENOL (2-sec-) {DNBP}	187-188
CYCLOHEXYL-4,6-DINITROPHENOL (2-)	187-188
bis(2-CHLOROETHOXY)METHANE	189-192
CHLORAL {TRICHLOROACETALDEHYDE}	189-192
TRICHLOROMETHANETHIOL	189-192
DINITROCRESOL (4,6-) {PHENOL,2,4-DINITRO-6-METHYL-}	189-192
HEPTACHLOR EPOXIDE	193
DIEPOXYBUTANE (1,2,3,4-) {2,2'-BIOXIRANE}	194
<u>CLASS 5</u>	
BENZOTRICHLORIDE {TRICHLOROMETHYLBENZENE}	195-196
METHAPYRILENE	195-196
PHENACETIN {N-[4-ETHOXYPHENYL]ACETAMIDE}	197-198
METHYL HYDRAZINE [5]	197-198
DIBROMOETHANE (1,2-) {ETHYLENE DIBROMIDE}	199

Table D-1. Principal Hazardous Organic Constituent Thermal Stability Index (continued)

Principal Hazardous Organic Constituent	Rank
AFLATOXINS	200
TRICHLOROETHANE (1,1,1-) {METHYL CHLOROFORM} [2]	201
HEXACHLOROETHANE [2]	202-203
BROMOFORM {TRIBROMOMETHANE} [2]	202-203
CHLOROBENZILATE	204-207
ETHYL CARBAMATE {URETHAN} {CARBAMIC ACID, ETHYL ESTER}	204-207
ETHYL METHACRYLATE {2-PROPENOIC ACID, 2-METHYL-,ETHYL ESTER}	204-207
LASIOCARPINE	204-207
AMITROLE {1H-1,2,4-TRIAZOL-3-AMINE}	208-209
MUSCIMOL {5-AMINOMETHYL-3-ISOAZOTOL}	208-209
IODOMETHANE {METHYL IODIDE}	210
DICHLOROPHENOXYACETIC ACID (2,4-) {2,4-D}	211-213
CHLOROETHYLVINYLETHER (2-) {ETHENE,[2-CHLOROETHOXY]-} [2]	211-213
METHYLENE BIS(2-CHLOROANILINE) (4,4-)	211-213
DIBROMO-3-CHLOROPROPANE (1,2-)	214
TETRACHLOROETHANE (1,1,1,2-) [2]	215
DIMETHYLHYDRAZINE (1,1-) [5]	216-217
N,N-DIETHYLHYDRAZINE {1,2-DIETHYLHYDRAZINE}	216-217
CHLOROMETHYLMETHYL ETHER {CHLOROMETHOXYMETHANE}	218-220
DIMETHYL-1-METHYLTHIO-2-BUTANONE,O-[(METHYLAMINO)-CARBONYL] OXIME (3,3-) {THIOFANOX}	218-220
DIMETHYLHYDRAZINE (1,2-)	218-220
CHLORDANE (ALPHA AND GAMMA ISOMERS)	221
bis(CHLOROMETHYL)ETHER {METHANE-OXYbis[2-CHLORO-]}	222-223
PARATHION [5]	222-223
DICHLOROPROPANE (2,2-) [5]	224
MALEIC HYDRAZIDE {1,2-DIHYDRO-3,6-PYRIDAZINEDIONE}	225
BROMOPHENYL PHENYL ETHER (4-) {BENZENE,1-BROMO-4-PHENOXY-}	226
bis(2-CHLOROISOPROPYL)ETHER	227-228
DIHYDROSAFROLE {1,2-METHYLENEDIOXY-4-PROPYLBENZENE}	227-228
METHYL METHANESULFONATE {METHANESUFONIC ACID, METHYL ESTER}	229
PROPANE SULFONE (1,3-) {1,2-OXATHIOLANE,2,2-DIOXIDE}	230
SACCHARIN {1,2-BENZOISOTHIAZOLIN-3-ONE,1,1-DIOXIDE}	231
METHYL-2-METHYLTHIO-PROPIONALDEHYDE-O-(METHYLCARBONYL)OXIME(2-)	232-233
METHYOMYL	232-233
HEXACHLOROPROPENE [2]	234
PENTACHLORONITROBENZENE {PCNB}	235-239
DIALLATE {S-(2,3-DICHLOROALLYL)DIISOPROPYL THIOCARBAMATE)	235-239
ETHYLENEIMINE {AZIRIDINE}	235-239
ARAMITE	235-239
DIMETHOATE	235-239
TRICHLOROPHENOXYACETIC ACID (2,4,5-) {2,4,5-T}	240-241
TRICHLOROPHENOXYPROPIONIC ACID (2,4,5-) {2,4,5-TP} {SILVEX}	240-241
tris(2,3-DIBROMOPROPYL)PHOSPHATE	242
METHYLAZIRIDINE (2-) {1,2-PROPYLENIMINE}	243-244
METHOXYCHLOR	243-244
BRUCINE {STRYCHNIDIN-10-ONE,2,3-DIMETHOXY-}	245-246
KEPONE	245-246
ISOSAFROLE {1,2-METHYLENEDIOXY-4-ALLYLBENZENE}	247-249
SAFROLE {1,2-METHYLENE-4-ALLYLBENZENE}	247-249
tris(1-AZRIDINYL) PHOSPHINE SULFIDE	247-249
DIMETHOXYBENZIDINE (3,3'-)	250
DIPHENYLHYDRAZINE (1,2-)	251
O,O-DIETHYLPHOSPHORIC ACID,O-p-NITROPHENYL ESTER	252

Table D-1. Principal Hazardous Organic Constituent Thermal Stability Index (continued)

Principal Hazardous Organic Constituent	Rank
CLASS 6	
n-BUTYLBENZYL PHTHALATE [2]	253
O,O-DIETHYL-O-2-PYRAZINYL PHOSPHOROTHIOATE	254
DIMETHYLAMINOAZOBENZENE	255
DIETHYL PHTHALATE	256-257
O,O-DIETHYL-S-METHYL ESTER OF PHOSPHORIC ACID	256-257
O,O-DIETHYL S-[(ETHYLTHIO)METHYL]ESTER OF PHOSPHORODITHIOIC ACID	258-259
CITRUS RED No. 2 {2-NAPHTHOL,1-[(2,5-DIMETHOXYPHENYL)AZO]}	258-259
TRYPAN BLUE	260
ETHYL METHANESULFONATE {METHANESULFONIC ACID, ETHYL ESTER}	261-265
DISULFOTON	261-265
DIISOPROPYLFLUOROPHOSPHATE {DFP}	261-265
O,O,O-TRIETHYL PHOSPHOROTHIOATE	261-265
Di-n-BUTYL PHTHALATE	261-265
PARALDEHYDE {2,4,6-TRIMETHYL-1,3,5-TRIOXANE} [5]	266
Di-n-OCTYL PHTHALATE [2]	267
OCTAMETHYLPYROPHOSPHORAMIDE {OCTAMETHYLDIPHOSPHORAMIDE}	268
bis(2-ETHYLHEXYL)PHTHALATE	269-270
METHYLTHIOURACIL	269-270
PROPYLTHIOURACIL	271
CLASS 7	
STRYCHNINE {STRYCHNIDIN-10-ONE}	272
CYCLOPHOSPHAMIDE	273-276
NICOTINE {(S)-3-[1-METHYL-2-PYRROLIDINYL]PYRIDINE}	273-276
RESERPINE	273-276
TOLUIDINE HYDROCHLORIDE {2-METHYL-BENZENAMINE HYDROCHLORIDE}	273-276
TOLYLENE DIISOCYANATE {1,3-DIISOCYANATOMETHYLBENZENE}	277
ENDRIN	278
BUTANONE PEROXIDE (2-) {METHYL ETHYL KETONE, PEROXIDE}	279
TETRAETHYLPYROPHOSPHATE	280
NITROGLYCERINE {TRINITRATE-1,2,3-PROPANETRIOL} [5]	281
TETRAETHYLDITHIOPYROPHOSPHATE	282
ETHYLENEbisDITHIOCARBAMIC ACID	283
TETRANITROMETHANE [5]	284
URACIL MUSTARD {5-[bis(2-CHLOROETHYL)AMINO]URACIL}	285
ACETYL-2-THIOUREA (1-) {ACETAMIDE,N-[AMINOTHIOXOMETHYL]-}	286-290
CHLOROPHENYL THIOUREA (1-) {THIOUREA,[2-CHLOROPHENYL]-}	286-290
N-PHENYLTHIOUREA	286-290
NAPHTHYL-2-THIOUREA (1-) {THIOUREA,1-NAPHTHALENYL-}	286-290
THIOUREA {THIOCARBAMIDE}	286-290
DAUNOMYCIN	291-292
ETHYLENE THIOUREA {2-IMIDAZOLIDINETHIONE}	291-292
THIOSEMICARBAZIDE {HYDRAZINECARBOTHIOAMIDE}	293-294
MELPHALAN {ALANINE,3-[p-bis(2-CHLOROETHYL)AMINO]PHENYL-,L-}	293-294
DITHIOBIURET (2,4-) {THIOIMIDODICARBONIC DIAMIDE}	295-296
THIURAM {bis[DIMETHYLTHIOCARBAMOYL]DISULFIDE}	295-296
AZASERINE {L-SERINE,DIAZOACETATE[ESTER]}	297
HEXAETHYL TETRAPHOSPHATE	298
NITROGEN MUSTARD N-OXIDE	299-300
NITROQUINOLINE-1-OXIDE (4-)	299-300
CYCASIN {beta-D-GLUCOPYRANOSIDE,[METHYL-ONN-AZOXY]METHYL-}	301

Table D-1. Principal Hazardous Organic Constituent Thermal Stability Index (continued)

Principal Hazardous Organic Constituent	Rank
STREPTOZOTOCIN	302
N-METHYL-N'-NITRO-N-NITROSOGUANIDINE	303-318
N-NITROSO-DI-ETHANOLAMINE-{[2,2'-NITROSOIMINO]bisETHANOL}	303-318
N-NITROSO-DI-N-BUTYLAMINE {N-BUTYL-N-NITROSO-1-BUTANAMINE}	303-318
N-NITROSO-N-ETHYLUREA {N-ETHYL-N-NITROSOCARBAMIDE}	303-318
N-NITROSO-N-METHYLUREA {N-METHYL-N-NITROSOCARBAMIDE}	303-318
N-NITROSO-N-METHYLURETHANE	303-318
N-NITROSODIETHYLAMINE {N-ETHYL-N-NITROSOETHANAMINE}	303-318
N-NITROSODIMETHYLAMINE {DIMETHYLNITROSAMINE}	**303-318**
N-NITROSOMETHYLETHYLAMINE {N-METHYL-N-NITROSOETHANAMINE}	303-318
N-NITROSOMETHYLVINYLAMINE {N-METHYL-N-NITROSOETHENAMINE}	303-318
N-NITROSOMORPHOLINE	303-318
N-NITROSONORNICOTINE	303-318
N-NITROSOPIPERIDINE {HEXAHYDRO-N-NITROSOPYRIDINE}	303-318
N-NITROSOSARCOSINE	303-318
NITROSOPYRROLIDINE {N-NITROSOTETRAHYDROPYRROLE}	303-318
DI-n-PROPYLNITROSAMINE {N-NITROSO-DI-n-PROPYLAMINE}	303-318
OXABICYCLO[2.2.1]HEPTANE-2,3-DICARBOXYLIC ACID (7-) {ENDOTHAL}	319
ENDOSULFAN	320

FOOTNOTES:

1. UNITS OF TEMPERATURE ARE DEGREES CELSIUS.

2. **BOLDFACE** INDICATES COMPOUND THERMAL STABILITY IS "EXPERIMENTALLY EVALUATED" (RANKING BASED ON UDRI EXPERIMENTAL DATA COUPLED WITH REACTION KINETIC THEORY).

3. NON-APPENDIX VIII COMPOUND.

4. N.O.S. LISTING; RANKING IS PRESENTED BASED ON EITHER UDRI OR LITERATURE EXPERIMENTAL DATA COUPLED WITH REACTION KINETIC THEORY.

5. *ITALICS* INDICATE COMPOUND THERMAL STABILITY IS RANKED BASED ON LITERATURE EXPERIMENTAL DATA COUPLED WITH REACTION KINETIC THEORY.

Table D-2. Principal Hazardous Organic Constituent Thermal Stability Index - Alphabetized

Principal Hazardous Organic Constituent	Rank
ACETONITRILE {ETHANENITRILE} [2]	17-18
ACETONYLBENZYL-4-HYDROXYCOUMARIN (3-alpha-) {WARFARIN}	98-99
ACETOPHENONE {ETHANONE, 1-PHENYL-} [2]	85-88
ACETYL CHLORIDE {ETHANOYL CHLORIDE} [2]	92-97
ACETYL-2-THIOUREA (1-) {ACETAMIDE,N-[AMINOTHIOXOMETHYL]-}	286-290
ACETYLAMINOFLUORENE (2-) {ACETAMIDE,N-[9H-FLUOREN-2-YL]-}	69-77
ACROLEIN {2-PROPENAL}	106-107
ACRYLAMIDE {2-PROPENAMIDE}	60-64
ACRYLONITRILE {2-PROPENENITRILE} [2]	20
AFLATOXINS	260
ALDRIN	162-164
ALLYL ALCOHOL {2-PROPEN-1-OL}	116-118
AMINOBIPHENYL (4-) {[1,1' BIPHENYL]-4-AMINE}	51
AMITROLE {1H-1,2,4-TRIAZOL-3-AMINE}	208-209
ANILINE {BENZENAMINE}	46-50
ARAMITE	235-239
AURAMINE	180-181
AZASERINE {L-SERINE,DIAZOACETATE[ESTER]}	297
BENZAL CHLORIDE {ALPHA, ALPHA-DICHLOROTOLUENE} [2]	168-173
BENZANTHRACENE (1,2-) {BENZ[a]ANTHRACENE}	9
BENZENE [2]	3
BENZENETHIOL {THIOPHENOL} [2]	110
BENZIDINE {[1,1'-BIPHENYL]-4,4' DIAMINE}	60-64
BENZOQUINONE {1,4-CYCLOHEXADIENEDIONE}	89-91
BENZOTRICHLORIDE {TRICHLOROMETHYLBENZENE}	195-196
BENZO[a]PYRENE {1,2-BENZOPYRENE}	11
BENZO[b]FLUORANTHENE {2,3-BENZOFLUORANTHENE}	8
BENZO[j]FLUORANTHENE {7,8-BENZOFLUORANTHENE}	7
BENZYL CHLORIDE {CHLOROMETHYLBENZENE} [2]	127-130
BENZ[c]ACRIDINE {3,4-BENZACRIDINE}	85-88
bis(2-CHLOROETHOXY)METHANE	189-192
bis(2-CHLOROETHYL)ETHER [2]	183-186
bis(2-CHLOROISOPROPYL)ETHER	227-228
bis(2-ETHYLHEXYL)PHTHALATE	269-270
bis(CHLOROMETHYL)ETHER {METHANE-OXYbis[2-CHLORO-]}	222-223
BROMOACETONE {1-BROMO-2-PROPANONE}	136-140
BROMOFORM {TRIBROMOMETHANE} [2]	202-203
BROMOMETHANE {METHYL BROMIDE} [2]	31-33
BROMOPHENYL PHENYL ETHER (4-) {BENZENE,1-BROMO-4-PHENOXY-}	226
BRUCINE {STRYCHNIDIN-10-ONE,2,3-DIMETHOXY-}	245-246
BUTANONE PEROXIDE (2-) {METHYL ETHYL KETONE, PEROXIDE}	279
BUTYL-4,6-DINITROPHENOL (2-sec-) {DNBP}	187-188
CHLORAL {TRICHLOROACETALDEHYDE}	189-192
CHLORAMBUCIL	142
CHLORDANE (ALPHA AND GAMMA ISOMERS)	221
CHLORO-1,3-BUTADIENE (2-) {CHLOROPRENE}	69-77
CHLORO-2,3-EPOXYPROPANE (1-) {OXIRANE,2-CHLOROMETHYL-}	183-186
CHLOROACETALDEHYDE	166-167
CHLOROANILINE {CHLOROBENZENAMINE}	37
CHLOROBENZENE [2]	19
CHLOROBENZILATE	204-207
CHLOROCRESOL {4-CHLORO-3-METHYLPHENOL}	116-118

Table D-2. Principal Hazardous Organic Constituent Thermal Stability Index - Alphabetized (continued)

Principal Hazardous Organic Constituent	Rank
CHLORODIFLUOROMETHANE [2] [4]	151-153
CHLOROETHANE (ETHYL CHLORIDE) [4] [5]	126
CHLOROETHYLVINYLETHER (2-) {ETHENE,[2-CHLOROETHOXY]-} [2]	211-213
CHLOROMETHANE {METHYL CHLORIDE} [2]	29-30
CHLOROMETHYLMETHYL ETHER {CHLOROMETHOXYMETHANE}	218-220
CHLORONAPHTHALENE (1-) [2]	21-22
CHLOROPHENOL (2-)	102
CHLOROPHENYL THIOUREA (1-) {THIOUREA,[2-CHLOROPHENYL]-}	286-290
CHLOROPROPENE (3-) {ALLYL CHLORIDE} [2]	120
CHLOROPROPIONITRILE (3-) {3-CHLOROPROPANENITRILE} [2]	143-144
CHRYSENE {1,2-BENZPHENANTHRENE}	10
CITRUS RED No. 2 {2-NAPHTHOL,1-[(2,5-DIMETHOXYPHENYL)AZO]}	258-259
CRESOL (1,2-) {METHYLPHENOL}	104-105
CRESOL (1,3-) {METHYLPHENOL}	103
CRESOL (1,4-) {METHYLPHENOL} [2]	104-105
CROTONALDEHYDE {2-BUTENAL} [2]	113-115
CYANOGEN BROMIDE {BROMINE CYANIDE}	23-24
CYANOGEN CHLORIDE {CHLORINE CYANIDE}	17-18
CYANOGEN {ETHANEDINITRILE}	1
CYCASIN {beta-D-GLUCOPYRANOSIDE,[METHYL-ONN-AZOXY]METHYL-}	301
CYCLOHEXYL-4,6-DINITROPHENOL (2-)	187-188
CYCLOPHOSPHAMIDE	273-276
DAUNOMYCIN	291-292
DDD {DICHLORODIPHENYLDICHLOROETHANE}	145-146
DDE{1,1-DICHLORO-2,2-BIS(4-CHLOROPHENYLETHYLENE}	38
DDT {DICHLORODIPHENYLTRICHLOROETHANE}	175-178
Di-n-BUTYL PHTHALATE	261-265
DI-n-OCTYL PHTHALATE [2]	267
DI-n-PROPYLNITROSAMINE {N-NITROSO-DI-n-PROPYLAMINE}	303-318
DIALLATE {S-(2,3-DICHLOROALLYL)DIISOPROPYL THIOCARBAMATE)	235-239
DIBENZO[a,e]PYRENE {1,2,4,5-DIBENZOPYRENE}	16
DIBENZO[a,h]PYRENE {1,2,5,6-DIBENZOPYRENE}	14
DIBENZO[a,i]PYRENE {1,2,7,8-DIBENZOPYRENE}	15
DIBENZO[c,g]CARBAZOLE (7H-) {3,4,5,6-DIBENZCARBAZOLE}	100-101
DIBENZ[a,h]ACRIDINE {1,2,5,6-DIBENZACRIDINE}	92-97
DIBENZ[a,h]ANTHRACENE {1,2,5,6-DIBENZANTHRACENE}	12
DIBENZ[a,j]ACRIDINE {1,2,7,8-DIBENZACRIDINE}	92-97
DIBROMO-3-CHLOROPROPANE (1,2-)	214
DIBROMOETHANE (1,2-) {ETHYLENE DIBROMIDE}	199
DIBROMOMETHANE {METHYLENE BROMIDE} [2]	127-130
DICHLORO-1-PROPANOL (2,3-)	168-173
DICHLORO-2-BUTENE (1,4-)	136-140
DICHLORO-2-PROPANOL (1,1-)	145-146
DICHLORO-2-PROPANOL (1,3-)	147
DICHLOROBENZENE {1,2-DICHLOROBENZENE} [2]	23-24
DICHLOROBENZENE {1,3-DICHLOROBENZENE} [2]	25
DICHLOROBENZENE {1,4-DICHLOROBENZENE}	21-22
DICHLOROBENZIDINE (3,3'-)	67
DICHLORODIFLUOROMETHANE [2]	85-88
DICHLOROETHANE (1,1-) {ETHYLIDENE DICHLORIDE} [5]	175-178
DICHLOROETHANE (1,2-) [2]	131
DICHLOROETHENE (1,1-) [2]	42-44

Table D-2. Principal Hazardous Organic Constituent Thermal Stability Index - Alphabetized (continued)

Principal Hazardous Organic Constituent	Rank
DICHLOROETHENE (trans-1,2-) [2]	54
DICHLOROFLUOROMETHANE [2] [4]	154-157
DICHLOROMETHANE {METHYLENE CHLORIDE} [2]	65-66
DICHLOROPHENOL (2,4-)	113-115
DICHLOROPHENOL (2,6-)	113-115
DICHLOROPHENOXYACETIC ACID (2,4-) {2,4-D}	211-213
DICHLOROPROPANE (1,1-) [5]	182
DICHLOROPROPANE (1,2-) {PROPYLENE DICHLORIDE} [5]	179
DICHLOROPROPANE (1,3-) [5]	165
DICHLOROPROPANE (2,2-) [5]	224
DICHLOROPROPENE (1,1-) [2]	81-84
DICHLOROPROPENE (2,3-)	127-130
DICHLOROPROPENE (3,3-)	135
DICHLOROPROPENE (cis-1,3-)	121-125
DICHLOROPROPENE (trans-1,2-)	89-91
DICHLOROPROPENE (trans-1,3-)	121-125
DIELDRIN	161-163
DIEPOXYBUTANE (1,2,3,4-) {2,2'-BIOXIRANE}	194
DIETHYL PHTHALATE	256-257
DIETHYLSTILBESTEROL	108-109
DIHYDROSAFROLE {1,2-METHYLENEDIOXY-4-PROPYLBENZENE}	227-228
DIHYDROXY-ALPHA-[METHYLAMINO]METHYL BENZYL ALCOHOL (3,4-)	106-107
DIISOPROPYLFLUOROPHOSPHATE {DFP}	261-265
DIMETHOATE	235-239
DIMETHOXYBENZIDINE (3,3'-)	250
DIMETHYL PHTHALATE [2]	92-97
DIMETHYL-1-METHYLTHIO-2-BUTANONE,O-[(METHYLAMINO)-CARBONYL] OXIME (3,3-) {THIOFANOX}	218-220
DIMETHYLAMINOAZOBENZENE	255
DIMETHYLBENZIDINE (3,3'-)	78
DIMETHYLBENZ[a]ANTHRACENE (7,12-)	45
DIMETHYLCARBAMOYLCHLORIDE	175-178
DIMETHYLHYDRAZINE (1,1-) [5]	216-217
DIMETHYLHYDRAZINE (1,2-)	218-220
DIMETHYLPHENETHYLAMINE (alpha, alpha-)	60-64
DIMETHYLPHENOL (2,4-)	119
DINITROBENZENE (1,2-)	158-161
DINITROBENZENE (1,3-)	154-157
DINITROBENZENE (1,4-)	158-161
DINITROCRESOL (4,6-) {PHENOL,2,4-DINITRO-6-METHYL-}	189-192
DINITROPHENOL (2,4-)	183-186
DINITROTOLUENE (2,4-)	168-173
DINITROTOLUENE (2,6-)	168-173
DIOXANE (1,4-) {1,4-DIETHYLENE OXIDE} [2]	141
DIPHENYLAMINE {N-PHENYLBENZENAMINE}	42-44
DIPHENYLHYDRAZINE (1,2-)	251
DISULFOTON	261-265
DITHIOBIURET (2,4-) {THIOIMIDODICARBONIC DIAMIDE}	295-296
ENDOSULFAN	320
ENDRIN	278
ETHYL CARBAMATE {URETHAN} {CARBAMIC ACID, ETHYL ESTER}	204-207
ETHYL CYANIDE {PROPIONITRILE} [2]	89-91
ETHYL METHACRYLATE {2-PROPENOIC ACID, 2-METHYL ,ETHYL ESTER}	204-207

Table D-2. Principal Hazardous Organic Constituent Thermal Stability Index - Alphabetized (continued)

Principal Hazardous Organic Constituent	Rank
ETHYL METHANESULFONATE {METHANESULFONIC ACID. ETHYL ESTER}	261-265
ETHYLENE OXIDE {OXIRANE} [5]	174
ETHYLENE THIOUREA {2-IMIDAZOLIDINETHIONE}	291-292
ETHYLENEbisDITHIOCARBAMIC ACID	283
ETHYLENEIMINE {AZIRIDINE}	235-239
FLUORANTHENE {BENZO[j,k]FLUORENE}	6
FLUOROACETAMIDE (2-)	55-56
FLUOROACETIC ACID	42-44
FORMALDEHYDE {METHYLENE OXIDE}	46-50
FORMIC ACID {METHANOIC ACID}	39-40
GLYCIDYALDEHYDE {1-PROPANOL-2,3-EPOXY}	175-178
HEPTACHLOR	180-181
HEPTACHLOR EPOXIDE	193
HEXACHLOROBENZENE [2]	31-33
HEXACHLOROBUTADIENE (trans-1,3) [2]	92-97
HEXACHLOROCYCLOHEXANE {LINDANE} [2]	151-153
HEXACHLOROCYCLOPENTADIENE	168-173
HEXACHLOROETHANE [2]	202-203
HEXACHLOROPHENE {2,2'-METHYLENEbis(3,4,6-TRICHLOROPHENOL)}	136-140
HEXACHLOROPROPENE [2]	234
HEXAETHYL TETRAPHOSPHATE	298
HYDRAZINE (DIAMINE)	127-130
HYDROGEN CYANIDE {HYDROCYANIC ACID} [2]	2
INDENO(1,2,3-cd)PYRENE {1,10-(1,2-PHENYLENE)PYRENE}	13
IODOMETHANE {METHYL IODIDE}	210
ISOBUTYL ALCOHOL {2-METHYL-1-PROPANOL} [2]	112
ISODRIN	162-164
ISOSAFROLE {1,2-METHYLENEDIOXY-4-ALLYLBENZENE}	247-249
KEPONE	245-246
LASIOCARPINE	204-207
MALEIC ANHYDRIDE {2,5-FURANDIONE}	98-99
MALEIC HYDRAZIDE {1,2-DIHYDRO-3,6-PYRIDAZINEDIONE}	225
MALONONITRILE {PROPANEDINITRILE}	46-50
MELPHALAN {ALANINE,3-[p-bis(2-CHLOROETHYL)AMINO]PHENYL-,L-}	293-294
METHACRYLONITRILE {2-METHYL-2-PROPENENITRILE} [2]	65-66
METHAPYRILENE	195-196
METHOXYCHLOR	243-244
METHYL CHLOROCARBONATE {CARBONOCHLORIDIC ACID, METHYL ESTER}	46-50
METHYL ETHYL KETONE {2-BUTANONE} [2]	108-109
METHYL HYDRAZINE [5]	197-198
METHYL ISOCYANATE {METHYLCARBYLAMINE}	46-50
METHYL METHACRYLATE {2-PROPENOIC ACID, 2-METHYL-, METHYL ESTER}	60-64
METHYL METHANESULFONATE {METHANESULFONIC ACID, METHYL ESTER}	229
METHYL PARATHION	148-150
METHYL-2-METHYLTHIO-PROPIONALDEHYDE-O-(METHYLCARBONYL)OXIME (2-	232-233
METHYLACTONITRILE (2-) {PROPANENITRILE,2-HYDROXY-2-METHYL}	116-118
METHYLAZIRIDINE (2-) {1,2-PROPYLENIMINE}	243-244
METHYLCHOLANTHRENE (3-)	68
METHYLENE BIS(2-CHLOROANILINE) (4,4-)	211-213
METHYLTHIOURACIL	269-270
METHYOMYL	232-233
MUSCIMOL {5-AMINOMETHYL-3-ISOAZOTOL}	208-209

Table D-2. Principal Hazardous Organic Constituent Thermal Stability Index - Alphabetized (continued)

Principal Hazardous Organic Constituent	Rank
MUSTARD GAS {bis[2-CHLOROETHY -SULFIDE}	132-134
N.N-BIS(2-CHLOROETHYL)2-NAPHTH AMINE {CHLORNAPHAZINE}	132-134
N.N-DIETHYLHYDRAZINE {1,2-DIETH HYDRAZINE}	216-217
n-BUTYLBENZYL PHTHALATE [2]	253
N-METHYL-N'-NITRO-N-NITROSOG NIDINE	303-318
N-NITROSO-DI-ETHANOLAMINE {[2 '-NITROSOIMINO]bisETHANOL}	303-318
N-NITROSO-DI-N-BUTYLAMINE {N- JTYL-N-NITROSO-1-BUTANAMINE}	303-318
N-NITROSO-N-ETHYLUREA {N-ET 'L-N-NITROSOCARBAMIDE}	303-318
N-NITROSO-N-METHYLUREA {N-M ETHYL-N-NITROSOCARBAMIDE}	303-318
N-NITROSO-N-METHYLURETHAN	303-318
N-NITROSODIETHYLAMINE {N-E YL-N-NITROSOETHANAMINE}	303-318
N-NITROSODIMETHYLAMINE {DI ETHYLNITROSAMINE}	303-318
N-NITROSOMETHYLETHYLAMIN {N-METHYL-N-NITROSOETHANAMINE}	303-318
N-NITROSOMETHYLVINYLAMINE {N-METHYL-N-NITROSOETHENAMINE}	303-318
N-NITROSOMORPHOLINE	303-318
N-NITROSONORNICOTINE	303-318
N-NITROSOPIPERIDINE {HEXA 'DRO-N-NITROSOPYRIDINE}	303-318
N-NITROSOSARCOSINE	303-318
N-PHENYLTHIOUREA	286-290
n-PROPYLAMINE {1-PROPAN IINE}	79
NAPHTHALENE [2]	5
NAPHTHOQUINONE (1,4-) {1 NAPHTHALENEDIONE}	92-97
NAPHTHYL-2-THIOUREA {1- THIOUREA,1-NAPHTHALENYL-}	286-290
NAPHTHYLAMINE (1-)	52-53
NAPHTHYLAMINE (2-)	52-53
NICOTINE {(S)-3-[1-METHY 2-PYRROLIDINYL]PYRIDINE}	273-276
NITROANILINE {4-NITROBE ZENAMINE}	154-157
NITROBENZENE [2]	143
NITROGEN MUSTARD	132-134
NITROGEN MUSTARD N-(KIDE	299-300
NITROGLYCERINE {TRINI 'ATE-1,2,3-PROPANETRIOL} [5]	281
NITROPHENOL (4-)	148-150
NITROQUINOLINE-1-OXIDE (4-)	299-300
NITROSOPYRROLIDINE N-NITROSOTETRAHYDROPYRROLE}	303-318
NITROTOLUIDINE (5-) {B ENZENAMINE,2-METHYL-5-NITRO-}	166-167
O,O,O-TRIETHYL PHOSPHOROTHIOATE	261-265
O,O-DIETHYL S-[(ETHY THIO)METHYL]ESTER OF PHOSPHORODITHIOIC ACID	258-259
O,O-DIETHYL-O-2-PYR ZINYL PHOSPHOROTHIOATE	254
O,O-DIETHYL-S-METH ESTER OF PHOSPHORIC ACID	256-257
O,O-DIETHYLPHOSPH RIC ACID,O-p-NITROPHENYL ESTER	252
OCTAMETHYLPYROF OSPHORAMIDE {OCTAMETHYLDIPHOSPHORAMIDE}	268
OXABICYCLO[2.2.1]H PTANE-2,3-DICARBOXYLIC ACID (7-) {ENDOTHAL}	319
PARALDEHYDE {2,4 TRIMETHYL-1,3,5-TRIOXANE} [5]	266
PARATHION [5]	222-223
PENTACHLOROBE ENE [2]	31-33
PENTACHLOROET ANE [2]	154-157
PENTACHLORONIT OBENZENE {PCNB}	235-239
PENTACHLOROPH NOL	151-153
PHENACETIN {N-[ETHOXYPHENYL]ACETAMIDE}	197-198
PHENOL {HYDRO YBENZENE}	100-101
PHENYLENEDIAM IE (1,2-) {BENZENEDIAMINE}	57-59
PHENYLENEDIAM IE (1,3-) {BENZENEDIAMINE}	57-59

Table D-2. Principal Hazardous Organic Constituent Thermal Stability Index - Alphabetized (continued)

Principal Hazardous Organic Constituent	Rank
PHENYLENEDIAMINE (1,4) {BENZENEDIAMINE}	57-59
PHOSGENE {CARBONYL CHLORIDE}	39-40
PHTHALIC ANHYDRIDE {1,2-BENZENEDICARBOXYLIC ACID ANHYDRIDE}	148-150
PICOLINE (2-) {PYRIDINE, 2-METHYL-}	81-84
PRONAMIDE {3,5-DICHLORO-N-[1,1-DIMETHYL-2-PROPYNYL] BENZAMIDE}	69-77
PROPANE SULFONE (1,3-) {1,2-OXATHIOLANE,2,2-DIOXIDE}	230
PROPYLTHIOURACIL	271
PROPYN-1-OL (2-) {PROPARGYL ALCOHOL}	55-56
PYRIDINE [2]	**80**
RESERPINE	273-276
RESORCINOL {1,3-BENZENEDIOL}	111
SACCHARIN {1,2-BENZOISOTHIAZOLIN-3-ONE,1,1-DIOXIDE}	231
SAFROLE {1,2-METHYLENE-4-ALLYLBENZENE}	247-249
STREPTOZOTOCIN	302
STRYCHNINE {STRYCHNIDIN-10-ONE}	272
SULFUR HEXAFLUORIDE [3]	4
TETRACHLOROBENZENE (1,2,3,5-TETRACHLOROBENZENE) [2] [4]	20
TETRACHLOROBENZENE (1,2,4,5-TETRACHLOROBENZENE)	29-30
TETRACHLORODIBENZO-p-DIOXIN (2,3,7,8-) {TCDD}	34
TETRACHLOROETHANE (1,1,1,2-) [2]	215
TETRACHLOROETHANE (1,1,2,2-) [2]	121-125
TETRACHLOROETHENE [2]	36
TETRACHLOROMETHANE {CARBONTETRACHLORIDE} [2]	136-140
TETRACHLOROPHENOL (2,3,4,6-)	136-140
TETRAETHYLDITHIOPYROPHOSPHATE	282
TETRAETHYLPYROPHOSPHATE	280
TETRANITROMETHANE [5]	284
THIOACETAMIDE {ETHANETHIOAMIDE}	81-84
THIOSEMICARBAZIDE {HYDRAZINECARBOTHIOAMIDE}	293-294
THIOUREA {THIOCARBAMIDE}	286-290
THIURAM {bis[DIMETHYLTHIOCARBAMOYL]DISULFIDE}	295-296
TOLUENE {METHYLBENZENE} [2]	35
TOLUENEDIAMINE (1,3-) {DIAMINOTOLUENE}	69-77
TOLUENEDIAMINE (1,4-) {DIAMINOTOLUENE}	69-77
TOLUENEDIAMINE (2,4-) {DIAMINOTOLUENE}	69-77
TOLUENEDIAMINE (2,6-) {DIAMINOTOLUENE}	69-77
TOLUENEDIAMINE (3,4-) {DIAMINOTOLUENE}	69-77
TOLUENEDIAMINE (3,5-) {DIAMINOTOLUENE}	69-77
TOLUIDINE HYDROCHLORIDE {2-METHYL-BENZENAMINE HYDROCHLORIDE}	273-276
TOLYLENE DIISOCYANATE {1,3-DIISOCYANATOMETHYLBENZENE}	277
TRICHLOROBENZENE (1,2,4-TRICHLOROBENZENE) [2]	26-27
TRICHLOROBENZENE (1,3,5-TRICHLOROBENZENE) [2] [4]	26-27
TRICHLOROETHANE (1,1,1-) {METHYL CHLOROFORM} [2]	201
TRICHLOROETHANE (1,1,2-) [2]	158-161
TRICHLOROETHENE [2]	41
TRICHLOROFLUOROMETHANE [2]	85-88
TRICHLOROMETHANE {CHLOROFORM} [2]	195-196
TRICHLOROMETHANETHIOL	189-192
TRICHLOROPHENOL (2,4,5-)	121-125
TRICHLOROPHENOL (2,4,6-)	121-125
TRICHLOROPHENOXYACETIC ACID (2,4,5-) {2,4,5-T}	240-241
TRICHLOROPHENOXYPROPIONIC ACID (2,4,5-) {2,4,5-TP} {SILVEX}	240-241

Table D-2. Principal Hazardous Organic Constituent Thermal Stability Index - Alphabetized (continued)

Principal Hazardous Organic Constituent	Rank
TRICHLOROPROPANE (1,2,3-) [2]	168-173
TRICHLORO-(1.2.2)-TRIFLUOROETHANE (1,1,2) [2] [3]	81-84
TRINITROBENZENE {1.3.5-TRINITROBENZENE}	183-186
tris(1-AZRIDINYL) PHOSPHINE SULFIDE	247-249
tris(2.3-DIBROMOPROPYL)PHOSPHATE	242
TRYPAN BLUE	260
URACIL MUSTARD {5-[bis(2-CHLOROETHYL)AMINO]URACIL}	285
VINYL CHLORIDE (CHLOROETHENE)	60-64

FOOTNOTES:

1. UNITS OF TEMPERATURE ARE DEGREES CELSIUS.

2. **BOLDFACE** INDICATES COMPOUND THERMAL STABILITY IS "EXPERIMENTALLY EVALUATED" (RANKING BASED ON UDRI EXPERIMENTAL DATA COUPLED WITH REACTION KINETIC THEORY).

3. NON-APPENDIX VIII COMPOUND.

4. N.O.S. LISTING; RANKING IS PRESENTED BASED ON EITHER UDRI OR LITERATURE EXPERIMENTAL DATA COUPLED WITH REACTION KINETIC THEORY.

5. *ITALICS* INDICATE COMPOUND THERMAL STABILITY IS RANKED BASED ON LITERATURE EXPERIMENTAL DATA COUPLED WITH REACTION KINETIC THEORY.

APPENDIX G

CHECKLIST FOR INSPECTION OF A NEW RCRA INCINERATOR

CHECKLIST FOR INSPECTION OF A NEW RCRA INCINERATOR

A. Verify installation of monitoring equipment as specified in permit/permit application.

Parameter	Type of Instrument	Location of Sensor	Specifications
1. Temperature			
a. Primary Chamber	________	________	________
b. Secondary Chamber	________	________	________
c. ________	________	________	________
d. ________	________	________	________
2. CO Emissions	________	________	________
3. O_2 Emissions	________	________	________
4. Flue Gas Flow Rate or Velocity or Equivalent Method: (________)	________	________	________

Parameter	Type of Instrument	Location of Sensor	Specifications
5. Feed Rate of Each Waste Stream to Each Combustion Chamber			
Chamber/Waste Stream			
a. ________	________	________	________
b. ________	________	________	________
c. ________	________	________	________
d. ________	________	________	________
e. ________	________	________	________
6. Pressure in Primary Chamber	________	________	________
7. Air Pollution Control			
a. ________	________	________	________
b. ________	________	________	________
c. ________	________	________	________
d. ________	________	________	________

Parameter	Type of Instrument	Location of Sensor	Specifications
8. Inlet Gas Temperature to Air Pollution Control Devices			
a. ________	________	________	________
b. ________	________	________	________
c. ________	________	________	________
9. Additional Key Parameters			
a. ________	________	________	________
b. ________	________	________	________
c. ________	________	________	________
d. ________	________	________	________
e. ________	________	________	________
f. ________	________	________	________
g. ________	________	________	________

B. Verify construction of the incinerator and support equipment in accordance with the specifications in the permit application. Develop a list of specifications to be verified.

C. Shakedown Period Requirements

   1. Verify no greater than 720 hr of testing with hazardous wastes, or

   2. Verify testing with hazardous wastes did not exceed the limits provided in the approved extension to the shakedown period.

   3. Verify compliance with operating conditions during shakedown period.

D. Compliance Schedule Requirements

Summary List of Compliance Schedule Items*	Adequate Response?

* Use additional pages if necessary.

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